# NON-VERBAL INTELLIGENCE AND NATIVE-AMERICAN NAVAJO CHILDREN: A COMPARISON BETWEEN THE CTONI AND THE WISC-III

by

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ABSTRACT

This study investigated the validity of the Comprehensive Test of Nonverbal Intelligence (CTONI) as a measure of intelligence for use with Native-American learning disabled students. Forty boys and ten girls between the ages of 7 and 16 and who are Native-American Navajo students with a learning disability in reading and/or mathematics participated in this study. Each participant was administered the CTONI, the WISC-III, and the WIAT. The results from this study indicated that the CTONI exhibited less variability among its composite IQ scores than the WISC-III. The CTONI and the WISC-III Full-scale IQ, Verbal IQ and Performance IQ correlate moderately. The CTONI and WISC-III are significantly predictive of reading achievement but account for less than 11% of the common variance. Yet, the CTONI and the WISC-III are moderately correlated with mathematics achievement. Factor Analytic Results suggest that the factorial structures of the CTONI and the WISC-III for this sample of Native-American students are consistent with the factorial structures proposed by the respective test authors. The CTONI appears to be a valid measure of intelligence for use with Native-American populations. The implications of the findings of the CTONI with Native American populations are discussed.

# CHAPTER 1

## INTRODUCTION

The controversy surrounding the use of standardized intelligence tests with minority children has received the attention of numerous investigators and practitioners alike since the inception of these tests. The major issue concerning the use of intelligence tests relates to the comparatively lower scores of minority group children on these tests as compared to Anglo children. Traditional intelligence tests, like the Wechsler scales, have been criticized because inferences that are based on the poorer test performance may lead to the denial of educational opportunities for minority group children (Brescia & Fortune, 1989; Mishra & Lord, 1982; Reynolds, 1982; Saccuzzo & Johnson, 1995; St. John, Krichev, & Bauman, 1976). The past three decades have witnessed a continuing debate of the validity of conventional intelligence tests for use with minority individuals.

Reynolds (1982) argues that the problems most often attributable to the use of intelligence tests with minority individuals typically fall into the following categories: (a) the content in the test is such that minority children have not been exposed to it culturally; the tests are predominantly designed around the experiences of middle class Anglo culture, (b) Ethnic minorities are not adequately represented in the normative sample, (c) Language proficiency requirements of the test may result in the test assessing familiarity with English rather than cognitive ability, (d) Bias in psychoeducational testing may result in inequitable social consequences such as disproportional numbers of minority children being placed into dead-end educational tracks, and (e) Tests do not accurately predict for minority children on a given criterion measure.

Intelligence Testing and Legal Concerns

The debate over such issues has lead to litigation, legislation, and research in an attempt to ensure nondiscriminatory assessment practices. As an example for the nondiscriminatory practices a number of court cases have recognized the bias in traditional intelligence tests and have led to the exploration and use of more fair testing practices. In line with the above stated concern several land mark court cases, such as Hobson v. Hansen, Larry P. et al. v. Wilson Riles et al., Diana v. California State Board of Education, and Guadalupe v. Tempe Elementary School District, have influenced the intellectual assessment practices of school psychologists when working with minority children. Compelling arguments have been made that traditional tests are culturally biased and serve to deny minority children equal educational opportunities.

The first significant legal challenge to the use of aptitude tests for assigning minority children to low-ability classes was Hobson v. Hansen (1967, 1969). This case involves the plaintiffs claiming that African-American children were disproportionately placed into the lower educational career tracks based upon aptitude test's results. Federal Judge Wright stated that because the aptitude tests were standardized primarily on white middle-class group, they produce inaccurate and misleading test scores for African-American students and violated the equal protection rights of the student under the 14th amendment. This case sparked a chain reaction of litigation (Jacob-Timm & Hartshorne, 1998).

One of the most significant court cases to impact the practice of school psychology was the Larry P. et al. v. Wilson Riles et al. (1984). The plaintiffs claimed that many African-American students were misclassified as mentally retarded due to the use of intelligence tests that were culturally biased. Judge Peckham ruled that the school failed to show that intelligence tests were valid for use with African-Americans and found intelligence tests to be racially and culturally discriminatory and enjoined the state from using any standardized intelligence test to identify African-American children for admission to any special education program without prior permission from the court. In 1992, Judge Peckham issued an order allowing intelligence tests to be used with parental permission (Jacob-Timm & Hartshorne, 1998).

In the Diana v. California State Board of Education (1970) case the plaintiffs alleged that the use of intelligence tests like the Stanford Binet and the Wechsler scales inappropriately classified limited English proficient students as mentally retarded. The consent decree in Diana required children to be assessed in their primary language or with tests that do not depend on knowledge of English – nonverbal intelligence tests (Jacob-Timm & Hartshorne, 1998).

A similar court case involving intelligence testing of limited English proficient children is the Guadalupe v. Tempe Elementary School District (1972) filed on behalf of Yaqui Indian and Mexican-American students in Arizona. The plaintiffs claimed that the intelligence tests inappropriately identified the children as mentally retarded due to the children's limited English proficiency. The court decree required that intellectual assessments must be conducted in the child's primary language or nonverbal measures must be used if the child's language is not English (Jacob-Timm & Hartshorne, 1998).

Similar concerns regarding the testing of children with disabilities have led to the federal legislation like the Individuals with Disabilities Education Act (IDEA), Public Law 94-142. This law authorized the allocation of additional monies from the state and federal government to the local educational agencies to provide for the unique needs of students identified for inclusion in special educational programs. A key element in the identification process is that IDEA requires that assessment instruments and procedures must meet nondiscriminatory evaluation requirements which include: (a) measures are administered in the child's dominant language or another appropriate mode of communication, (b) measures are validated for the specific purpose for which they are used, and (c) measures are given by a trained examiner in conformance with the instructions provided by the test producer.

## Purpose of the Study

Despite legal and legislative mandates to ensure nondiscriminatory assessment practices and research attempts to develop valid measures, confusion still persists among practitioners regarding the validity of commonly used intelligence tests with minority children. The controversies of intellectual assessment of minority individuals have led to the search for alternative assessment methods. "Culture-fair" measures were developed and purported to measure ability without an emphasis on language or cultural experiences. These instruments typically include tasks without time limits and require little written or oral expression from the examinee. Attempts to develop culture-fair instruments have not been without critical problems. Many of the culture-fair intelligence tests sampled only a small portion of cognitive skill and many did not correlate well with school achievement.

The present study is a response to the need to examine a recently published and supposedly cultural-fair measure of intelligence with a cultural group frequently ignored in the scientific literature. This study investigated the validity of the Comprehensive Test of Nonverbal Intelligence (CTONI; Hammill, Pearson, & Weiderholt, 1997) as a measure of intelligence for learning disabled Native-American children and youth. More specifically, the primary focus of this study is the validity of the CTONI composite scores (Pictorial Nonverbal IQ, Geometric Nonverbal IQ, and Nonverbal IQ) by comparing them with the Performance IQ, Verbal IQ, and Full-scale IQ scores from the WISC-III. Second, this study investigated the degree that the CTONI IQ scores predict academic achievement. Finally, this study intended to examine the factorial validity of the six subtests of the CTONI (Pictorial Analogies, Geometric Analogies, Pictorial Categories, Geometric Categories, Pictorial Sequences, and Geometric Sequences) through principal component analysis.

# CHAPTER 2

# REVIEW OF THE LITERATURE

The purpose of this chapter is to provide a comprehensive review of the literature pertaining to research on the intellectual assessment of Native-Americans. A particular emphasis for this review is given to research comparing nonverbal measures of intelligence with the Wechsler intelligence scales.

## Culture and Intelligence

There is a considerable amount of agreement on the view that not all cultures perceive intelligence in the same way, or consider a common set of behaviors to be representative of intelligence (Senior, 1993). Intelligence is a cultural invention to account for the fact that some people are able to succeed in similar environments better then others. An assumption underlying verbal intelligence tests is that the test samples from a common body of experience and more intelligent children extract more knowledge from this common body of experience than do less intelligent children (Common & Frost, 1988). However, this logic breaks down when applied to children who have a significantly different body of experiences. Cultural differences between groups may exert a profound influence on the development of distinct patterns of mental abilities (Senior, 1993). Generally, when traditional intelligence tests are used with Native-American students the tests usually produce lower scores for the Native-American test taker (Brescia & Fortune, 1989). Decisions based on these tests for the Native-American students have the potential to cause grave harm or deny educational opportunities. The underestimation of Native-American intellectual abilities may result from several factors related to cultural beliefs.

## Factors Affecting Intellectual Performance of Native-Americans

### Test Taking Skills

Some Native-American students fail to exhibit successful test taking behaviors due in part to cultural beliefs pertaining to competing against others. Cultural beliefs in some tribes bar competitive behaviors between individuals and reward unassuming behaviors (McShane & Plas, 1984). Thus, the Native-American student may not realize the importance of doing his or her personal best on intelligence tests. Similarly, traditional intelligence tests, like the verbal sections of the Wechsler scales, involve direct questions and answer sequences which are considered rude by some Native-American tribes (Brandt, 1984). Hynd and Garcia (1979) suggest that the reason direct questions may be offensive to Native-Americans is that many Native-American religious beliefs hold that asking direct questions can result in the examiner gaining spiritual control of the examinee. Thus, Native-American students may be reluctant to perform at their optimal level on verbal intelligence tests. Finally, many Native-American tribes value a visual style of learning where instruction comes in the form of observation (McShane & Plas, 1984). This visual learning style may foster visual spatial cognitive abilities and not verbal question and response cognitive skills.

Speed Factor

The use of speed in traditional intelligence tests is an important consideration that affects the ability scores of students from minority cultures. The importance of speed to intelligence is largely a cultural notion. In some cultures, speed essentially plays no role and in others timing may vary substantially (Brandt, 1984; Senior, 1993). Timing patterns for response are different for Anglo and Native-Americans due to both bilingualism and differences in allocation of speaking turns. Verbal communication among Native-Americans commonly has longer wait periods before the next person speaks (Brandt, 1984). Timing may adversely affect Native-American test performance. The typical Anglo English speaker will wait one to two seconds for a response. An 11 to 12 second wait time is more common for Native-Americans (Brandt, 1984). Tests that place a premium on speed thus impose a bias against members from such cultures.

Otitis Media

An emphasis on nonverbal communication by Native-American children may result from frequent episodes of otitis media. Otitis media is a middle ear infection which is very common among Native-American children (McShane & Plas, 1984). It is possible that the Native-American child may develop effective observational strategies to compensate for reduced verbal input during chronic episodes of otitis media (Brandt, 1984). Verbal IQ score scores on the Wechsler scales have been found to be negatively correlated with the number of episodes of otitis media (McShane & Plas, 1984).

Language

When assessing Native-American children's intellectual abilities, the most important consideration is language skill. The failure of many Native-American students to do well on traditional intelligence tests results from poor reading and verbal abilities (Brescia & Fortune, 1989; McShane & Plas, 1984; Senior, 1993). Reservation life may produce children who are monolingual in a Native-American language, completely bilingual, with varying degrees of fluency in the two languages, or monolingual in English with varying degrees of standard or a Native-American variety (Brandt, 1984). The influence of English as a second language on test scores is further compounded by the fact that many Native-American languages are frequently non-written languages based on oral tradition (Senior, 1993).

Senior (1993) suggests that limited English language skill is the major reason why the utility of traditional intelligence tests with Native-American individuals needs to be reevaluated. One solution to the problem of language proficiency and the cultural loading of traditional intelligence tests is the use of nonverbal measures of intelligence. Prewell and Farhney (1994) suggest that tests which avoid language use are better estimates of cognitive ability when used with bilingual and culturally diverse populations.

Tests that measure nonverbal intelligence should possess three essential characteristics (Coleman et al., 1993). First, the test should be administered by nonverbal means or by ensuring that the test is a homogeneous measure of nonverbal abilities. The tasks should require fluid reasoning abilities and should not depend upon the individual's culture. Second, the test must require subjects to use complex reasoning abilities. Tests that require analogies and concept formation are best suited for this purpose (Coleman et al., 1993). Third, the assessment of nonverbal intelligence should require flexibility in the examinee's application of reasoning strategies. Various strategies may be employed to solve the same problem or they may need to change as problems increase in difficulty (Coleman et al., 1993). Measures of nonverbal intelligence offer an alternative method for populations who traditionally have been difficult to assess such as minority and limited English proficient individuals (Coleman et al., 1993).

In the following section of this chapter research related to traditional intelligence tests and to nonverbal measures of intelligence with Native-American children is reviewed.

## Validity Studies

Increasing numbers of Native-American children are attending public schools. Yet, remarkably little empirical psychoeducational research has been conducted with Native-American children (Hynd & Garcia, 1979). Consequently it seems reasonable to assume that school psychologists will more likely find themselves working with Native-American children and have little research to guide their interpretations (Hynd & Garcia, 1979).

One of the earliest attempts to assess Native-American's intellectual potential was conducted by Samuel Morton in the mid 1800s. Morton measured the cranial volume in cubic inches of the skulls of 144 American Indians. He believed that the volume of a skull was directly proportional to the intellectual capacity. In his estimation Native-Americans were close to the bottom of the distribution of human intelligence. It is believed that Morton's research was an attempt to prove his own prejudices against minorities and to promote his notions regarding racial origins and intelligence (Common & Frost, 1988; Senior, 1993). Morton's research seems simplistic in light of what is known today about neuropsychology and cognitive science. Yet, modern research into the intellectual abilities of Native-Americans has continued to be beset with methodological problems and interpretive difficulties. The following section of this chapter covers the research literature pertaining to studies investigating the validity of traditional tests of intelligence like the Wechsler scales and the Kaufman Assessment Battery for Children. The Wechsler scales are the most commonly used and researched measure of intelligence. Common and Frost (1988) suggest that there is a pressing need to search for more appropriate ways to assess the intellectual abilities of Native-American children because of the questionable validity of the Wechsler scales with these children.

Construct Validity

St. John, Krichev, and Bauman (1976) investigated the verbal and performance abilities of 100 Ojibwa and Cree Indian children between the ages of six and fifteen on the WISC. The results indicated that the Performance IQ was significantly higher then the Verbal IQ and that the magnitude of the difference decreased with age. Additionally, those students who were bilingual or spoke only English had significantly higher Verbal IQ and Full-scale IQ scores then did the limited English proficient students. St. John et al. (1976) suggest that the WISC Verbal IQ score is measuring the degree of acculturation and that the use of the Full-scale IQ with Native-American children would lead to erroneous impressions of the child's ability.

Zarske, Moore, and Peterson (1981) examined the factorial structure of the WISC-R for a group of 192 learning disabled Navajo and 50 Papago (Tohono O'odham) Indian children ranging in age from 6 to 15. The two-factor solution for both groups closely resembled the WISC-R verbal and performance factors. Factor one for both groups consisted of Vocabulary, Similarities, Information, and Comprehension subtests. Factor two consisted of Object Assembly, Picture Arrangement, and Picture Completion for both groups. The two groups differed on factor two in that Block Design loaded on factor two for the Papago group but not for the Navajo group and the Digit Span subtest loaded on factor two for the Navajo group but not for the Papago group. The results support a verbal and performance factorial structure for Native-Americans on the WISC-R. However, the Freedom from Distractibility factor did not emerge for either group.

McShane and Plas (1982) investigated the factorial structure of the WISC-R with Ojibwa Indian children. Seventy-seven Ojibwa children were randomly drawn from a reservation school. The children's ages ranged from 6.2 to 13.6. Two factor analyses were conducted on two separate sets of subtests from the WISC-R. The first factor analysis was conducted on all 12 subtests. The results did not match the expected verbal/performance factor structure. A three-factor solution was evident but half of the subtests (Information, Similarities, Vocabulary, Coding, Picture Arrangement, and Picture Completion) loaded on more than one factor. The first factor was composed of only the Comprehension subtest. Arithmetic and Digit span comprised the second factor. Finally, the third factor consisted of Block Design, Object Assembly, and Mazes. McShane and Plas (1982) did not offer an interpretation of this analysis except to suggest that the verbal and perceptual organization factorial structure did not materialize for this group of Native-Americans. The second factor analysis consisted of the eight subtests suggested by Naglieri, Kamphaus, and Kaufman (1983) that should be considered measures of simultaneous and successive processing. Accordingly the simultaneous processing factor is hypothesized to consist of Similarities, Picture Completion, Block Design, and Object Assembly. The Successive Processing factor is expected to contain Picture Arrangement, Coding, Mazes, and Digit Span. The results from this study did not support the successive and simultaneous factor structure.

Mishra (1982) conducted an item analysis of the WISC-R with 40 Anglo and 40 Navajo children to assess the degree of test bias. In this sample of children, ages ranging from 9.1 to 11.4, the results indicated that 19% of the 79 items in the Information, Similarities, and Vocabulary subtests were biased against the Navajo children. Mishra (1982) suggests that Native-American children may not have an adequate opportunity to learn the vocabulary or concepts measured by these subtests relative to the experiences of the Anglo group.

Teeter, Moore, and Petersen (1982) explored the WISC-R performance among 452 Navajo children. The children participating in this study came from three educational groups--non-disabled 113, learning disabled 150, and emotionally disabled 189. All three groups scored well below the normative mean on the Verbal IQ and Full-scale IQ. The non-disabled group and the emotionally disabled group scored in the average range on the Performance IQ score. Teeter et al. (1982) suggest that the Verbal IQ should be interpreted as a measure of linguistic and cultural differences and that the Performance IQ is the least biased measure of intelligence on the WISC-R. They go on to suggest that the Full-scale IQ yields a biased measure of intelligence and should not be used as an overall index of intellectual functioning for Native-American children.

Mishra, Lord, and Sabers (1989) analyzed WISC-R subtests for successive and simultaneous processing factor structure with 45 learning disabled and 41 gifted Navajo students. In this study only those subtests suggested by Naglieri et al. (1983) as measures of successive and simultaneous processing were included in the analysis. The results suggest that the WISC-R is composed of a simultaneous factor consisting of Similarities, Picture Completion, Picture Arrangement, Block Design, and Object Assembly and a Successive factor containing Digit Span and Coding. Mishra et al. (1989) suggest that these results are not without interpretive difficulties. The gifted students appear to use successive processing strategies on the Similarities subtest and the learning disabled students used both successive and simultaneous processing methods to solve the Picture Arrangement subtest.

Kowall, Watson, and Madak (1990) assessed the concurrent validity of the Test of Nonverbal Intelligence and the WISC-R with 30 Anglo and 22 Native-Canadian children who had been referred for evaluation because of slow academic progress. The Anglo and Native-Canadian children did not differ significantly on the TONI or on the Performance IQ. The Anglo children scored higher on the Verbal IQ than did the Native-Canadian children. The Native-Canadian children's TONI score was significantly higher than their Verbal IQ or Full-scale IQ. The Anglo children's TONI and Verbal IQ were not significantly different. Kowall et al. (1990) suggest that the TONI may not be a multidimensional test of nonverbal intelligence but rather a test of visual organization, visual comprehension, and attention to visual details. They further suggest that when individuals do not have deficits in these areas the TONI Quotient can be considered a reasonable equivalent to the WISC-R Performance IQ. Kowall et al. (1990) found the TONI to be correlated with the WISC-R Verbal IQ at .61, Performance IQ at .81, and the Full-scale IQ at .87. The TONI may not be an appropriate measure of global intelligence for learning disabled students. Yet, the TONI Quotient may be a better estimate of global intelligence for Native-Canadian children.

Davidson (1992) investigated the hypothesis that Native-American children have greater strengths in simultaneous processing over sequential processing. Davidson (1992) administered the K-ABC to 57 Native-American Crow and 60 Anglo children.

The sample's ages ranged from 7 to 12.5 years. The Native-American and Anglo children did not differ significantly on the K-ABC Mental Processing Composite. The Native-American children did score significantly higher on Simultaneous processing than the Anglo children. Similarly, the Anglo children scored significantly higher on Sequential processing than the Native-American children. Yet, there were no discrepancies between the Sequential and Simultaneous scores for either group. Davidson (1992) suggests that this study does not support the hypothesis that Native-American children do not predominantly process information in a simultaneous manner.

D'Amato, Lidiak, and Lassiter (1994) investigated the TONI as a culture-fair nonverbal measure of intelligence. Seventy-four students between the ages of 6 and 15 years old, who were referred for testing due to academic problems, participated in this study. Ninety-five percent of the sample was Anglo. The results suggested that the TONI Quotient is moderately correlated with the WISC-R scores--Verbal IQ (.55), Performance IQ (.58), and Full-scale IQ (.59). D'Amato et al. (1994) suggest that since the correlation is essentially of the same magnitude across the three WISC-R scores the results do not support the view that the TONI is a measure of nonverbal intelligence. D'Amato et al. (1994) suggest that the TONI is best described as a measure of simultaneous processing rather then nonverbal processing.

Curran, Elkerton, and Steinberg (1996) compared the concurrent validity of the WISC-III and the Snijders-Oomen Nonverbal Test of Intelligence - Revised (SON-R) with a group of 28 Native-American children ranging in age from 6 to 17 years old.

English was the primary language for all of the children. There was no significant difference between the WISC-III Full-scale IQ and the SON-R SIQ. The mean IQ score for each test was 97.4 SIQ, 95.5 Full-scale IQ, 102.3 Performance IQ, and 90.5 Verbal IQ. The results indicate that there were no significant differences between any of the IQ scores suggesting that the results do not support the hypothesis that Native-American students should perform better on nonverbal measures of intelligence than on more traditional intellectual measures like the WISC-III. The SON-R was significantly correlated with the WISC-III Verbal IQ, Performance IQ, and Full-scale IQ score at .51, .52, and .68 respectively. The SON-R subtest correlated significantly with Arithmetic, Block Design, Vocabulary and Symbol Search from the WISC-III. Comprehension, Picture Arrangement, Picture Completion, and Similarities did not significantly correlate with the SON-R. Curran et al. (1996) suggests that the SON-R is measuring fluid intelligence not fully measured by the WISC-III. However, conclusions from this research must be tempered by the small sample size.

Hammill, Pearson, and Wiederholt (1997) examined the item bias on the Comprehensive Test of Nonverbal Intelligence (CTONI) with a group of Native-American and Non-Native-American subjects who were included in the CTONI's norming data. Item Response Theory and Delta score approaches were employed to assess item bias. The Item Response approach generates Item Characteristic Curves (ICC) which represent the mathematical functions that show the probability of an examinee's correct response to an item in relationship to overall ability being measured.

Comparisons between different group's ICC can be tested for statistical significance using a chi-square procedure. A relatively small number of CTONI items were found to be statistically significant. Seven of the 150 items administered to both the Native-American and the Non-Native-American groups were found to be biased against the Native-American sample. No items in the Picture Analogies, Geometric Categories, or in the Pictorial Sequences subtests were found to be biased. Two items from the Geometric Analogies and the Geometric Sequences subtests were found to be biased. Three items from the Pictorial Categories subtest were found to be biased. The Delta score approach to assess bias, a linear z-scale transformation of item difficulties, indicates the degree of group resemblance for item difficulties when rank order is controlled. The Delta values are reported in correlation coefficients. The larger the coefficients the smaller the bias in the test. The Delta values for the CTONI ranged from .98 for Pictorial Analogies and Geometric Sequences to .99 for the remaining subtests. The CTONI items contain very little or no item bias for Native-American individuals. Hammill et al. (1997) recommend the use of the CTONI as an alternative measure of intelligence with minority and bilingual populations.

Predictive Validity

Mishra and Lord (1982) investigated the reliability and predictive validity of the WISC-R with a group of 40 randomly selected fourth and fifth grade Navajo students. Alpha correlations among the WISC-R subtests ranged from a high of .86 for Performance IQ to a low of .40 on the Information subtest. The average reliability correlations for the performance subtests were .81 and for the verbal subtests were .54. The predictive validity of all the WISC-R subtests as well as the Verbal IQ, Performance IQ, and the Full-scale IQ were low and non-significant when predicting the WRAT spelling, arithmetic, and reading scores. The only WISC-R subtest to significantly correlate with the WRAT was the Block Design subtest and Spelling. Mishra and Lord (1982) suggest that the validity of the WISC-R is questionable with Native-American populations.

Naglieri (1984) evaluated the concurrent and predictive validity of the K-ABC with a group of 35 Navajo children selected at random from regular education classes. The children's ages ranged from six to 12.5. Each child was administered the K-ABC, WISC-R, and the PIAT. Results suggest that the children demonstrated a discrepancy between WISC-R Verbal IQ and Performance IQ where the Performance IQ was significantly higher then the Verbal IQ. The results also showed that the Native-American children had significantly higher K-ABC Mental Processing Composite scores then the WISC-R Full-scale IQ. Sequential and Simultaneous processing scores were also significantly different. The Native-American children scored higher on Simultaneous Processing then on Sequential Processing. Naglieri (1984) suggests that this may not be due to greater strengths in one processing ability over another. He suggests that this difference may be a reflection of the highly verbal nature of the K-ABC sequential subtests. The K-ABC non-verbal subtests correlated .92 with Simultaneous Processing and correlated .55 with Sequential Processing. The K-ABC nonverbal scale was moderately correlated, .42, with the PIAT where as the Performance IQ correlated .23. The highest correlation was between the PIAT and the WISC-R Verbal IQ (.64). Naglieri (1984) suggests that the Verbal IQ is measuring language and acculturation experience among this sample of Native-Americans.

McCullough, Walker, and Diessner (1985) investigated the verbal and performance abilities of 75 Native-American children enrolled in a tribally operated junior and senior high schools. The sample consisted of 88% Yakima Indian and 12% Great Plains Indian children whose ages ranged from 12 to 19 years. All of the children were administered either the WISC-R or the WAIS depending on the child's age. The results suggest a significant Verbal IQ and Performance IQ discrepancy for both junior and senior high students. The Verbal IQ and Performance IQ did not correlate significantly for either group. Nevertheless, the Verbal IQ and Full-scale IQ were significant predictors of reading achievement. The Performance IQ was not a significant predictor of reading. Despite the relationship between the WISC-R and WAIS Verbal IQ and Full-scale IQ with reading achievement, McCullough et al. (1985) advise the use of caution when interpreting Wechsler intelligence scores for Native-Americans.

Sidles and MacAvoy (1987) investigated the Ravens Standard Progressive Matrices' (RSPM) ability to predict achievement among 124 Navajo students living on the reservation. The RSPM is a nonverbal measure of intelligence requiring individuals to select a missing figure through analogical reasoning. The age of the children ranged from 14 to 16 years and all of the participants were bilingual English/Navajo. Two thirds of the children preferred to speak only Navajo and none of the children had a history of academic difficulties or special education placement. The RSPM correlated significantly with the California Test of Basic Skills reading, spelling, language, and mathematics at .40, .39, .48, and .46 respectively. Sidles and Macavoy (1987) suggest that the RSPM appears to be a good measure of general intelligence and visual spatial abilities and is moderately related with academic achievement.

Whorton and Morgan (1990) compared the TONI and the WISC-R on a special education referred group of 29 Anglo and 17 Native-American children. The mean age of the children was 11.4. The correlation between the TONI Quotient and the WISC-R Verbal IQ, Performance IQ, and Full-scale IQ were .68, .42, and .48 respectively. The two groups of children did not differ significantly on any of the IQ scores. The results suggest that the TONI may be a valid estimate of intellectual ability for both Anglo and Native-American populations.

Atkinson (1993) compared the WISC-III verbal and performance scores from a non-referred and a referred group of Navajo children. The volunteer group consisted of 47 elementary children and the referred group consisted of 45 children. For both groups the Verbal IQ was significantly below the Performance IQ and Full-scale IQ. Atkinson (1993) suggests that this discrepancy supports the research suggesting Native-Americans may have better developed spatial abilities. Additionally, Atkinson (1993) suggests that the Full-scale IQ clearly is not a good representation of "g" for Native-Americans due to the large verbal/performance discrepancy. Atkinson (1993) also suggests that despite the significantly low Verbal IQ scores for both groups that the Verbal IQ and Performance IQ are good predictors of achievement as measured on the WIAT.

MacAvoy, Orr, and Sidles (1993) investigated the validity of the Ravens Colored Progressive Matrices (RCPM) and the RSPM with a group of 908 elementary and secondary Navajo students. The results of this study suggest that the RCPM does not contain the necessary item difficulty to serve the purpose of identifying giftedness for Native-Americans except for second grade children. The RSPM has similar limitations. It appears to have a sufficient ceiling up to grade nine but not beyond. Correlational data suggests that the RCPM and RSPM have low to moderate positive relationship with the Iowa Test of Basic Skills. The RCPM and the RSPM correlated highest with language achievement for second through twelfth grade students.

Saccuzzo and Johnson (1995) administered the RSPM to 16,985 children referred for gifted educational programs. The sample was composed of 3,864 Hispanic 6,286; Anglo 2,389; African-American 483; Asian 104; Pacific Islanders 1,419; Filipino 958; Indochinese 75; Native-American and 1,407. The purpose of the study was to assess bias by investigating the proportionate representation of gifted students that would be generated by the WISC-R and the RSPM. The results for the Native-American sample suggest that the WISC-R has a tendency to under predict the number of gifted Native-American children than what would be expected in the general population. However, the number of Native-American children predicted by the RSPM is nearly equal to what would have been expected.

## Summary of Literature Review

The construct validity of the Wechsler scales for Native-American children have been questioned. Zarske et al. (1981) suggested that the WISC-R has essentially the same verbal and performance factor structure as hypothesized by the test manual. However, Mishra et al. (1989) suggest that the WISC-R is better defined as a measure of simultaneous and successive processing for Native-American children. Naglieri (1984) and Davidson (1992) found support for successive and simultaneous cognitive processing dichotomy for Native-Americans on the K-ABC. Yet, McShane and Plas (1982) did not find support for either the expected verbal and performance factor structure or the simultaneous and successive factor structure for the WISC-R.

The Wechsler scales clearly show a Verbal IQ and Performance IQ discrepancy where Native-American children perform at the average level of cognitive ability on the Performance IQ score but significantly below average on the Verbal IQ score (Atkinson, 1993; McCullough et al., 1985; Naglieri, 1984; St. John et al., 1976; and Teeter et al., 1982). Despite the Verbal IQ and Performance IQ discrepancy, the utility of these scores in predicting academic achievement is still uncertain for Native-American children. Thus, the literature is uncertain in describing the cognitive processing abilities of Native-American children on traditional intelligence tests.

The literature on nonverbal measures of intelligence with Native-American populations is very limited and is in need of research studies dealing with newly developed tests such as the CTONI. The present study is intended to address this need.

# CHAPTER 3

# METHOD

This chapter describes the sample used in this study and the population from which the sample was selected. Additionally, this chapter will describe the method in which participants were recruited, the procedure used for collecting data, the tests used, and the hypotheses investigated. Finally, the methods used to analyze the data are reviewed.

## Sample

The sample for this study consisted of 50 Native-American Navajo students who were evaluated for special education and were subsequently identified with a learning disability. This sample consisted of 40 boys and 10 girls. The ages of the participating students ranged from 7-years 2-months to 16-years 3-months (the mean age is 11-years 4-months with a standard deviation of 2-years 5-months). All of the participants were enrolled in a public school district located in Northern Arizona. The school district is located on the northwest corner of the Navajo Reservation.

## Population in Context

The school district from which the sample was selected serves approximately 3,700 students, preschool through grade 12. Sixty percent of the student body is Native-American Navajo. The school district reports that 55% of the preschool children enrolled speak the Navajo language. An article written by Kammer (1993) in the Arizona Republic states that unemployment on the Navajo reservation was approximately 50%

and the average annual income per capita was $5,200. Additionally, the public infrastructure is very limited on the reservation such that 77% of the homes did not have telephones, 70% did not have access to public sewage, and 30% lacked complete plumbing. The combination of geographic isolation and economic conditions of the community limits the exposure these children have to standard English and middle class American culture. The environmental circumstances these students live in tend to have profound influences on the scores they obtain on traditional measures of intellectual ability.

## Sampling Procedures

After placement into special education was considered by the school district's Multidisciplanary Team, parental consent was requested for participation in this study. After consent was obtained (Appendix A) demographic and necessary test data were obtained from the student's special education file. All participants met the following criteria before being recruited for this study. First, each participant was identified as a Native-American Navajo student whose dominant language is English. The information regarding ethnicity and English language dominance came from the parent-completed Developmental History Form that is provided to all parents whose child has been referred for comprehensive special education evaluation by the school district.

Second, all student participants had been previously identified as having a specific learning disability in mathematics and/or in reading. The criteria used by the school district for identification of students with a learning disabilities was adopted for this study. The identification as a learning disabled student requires that the student must have at least average intellectual potential and a significant discrepancy in academic achievement. For the purpose of this study average intellectual potential is defined as having least a Performance IQ score of 80 on the WISC-III. Additionally, a significant discrepancy between the participant's intellectual ability and academic achievement is defined here as a WIAT Reading Composite or Mathematics Composite score that is significantly below the participant's predicted achievement score as determined by the regression formula method provided in the WIAT manual.

Third, all participants had the following test scores as part of their comprehensive evaluation: Performance, Verbal, and Full-scale IQ scores from the WISC-III; Pictorial Nonverbal, Geometric Nonverbal, and the Full-scale Nonverbal IQ scores from the CTONI; and the Reading Composite and Mathematics Composite scores from the WIAT.

Fourth, all participants' visual and auditory acuity was screened and determined to be within normal limits or correctable with glasses. The vision and hearing screening provided by the school nurse was used to determine this criterion.

## Tests and Testing Procedures

Each participant was evaluated by two well-trained school psychologists. The school psychologists administered the following tests as part of the student's comprehensive special education evaluation--the Comprehensive Test of Nonverbal Intelligence, the Wechsler Intelligence Scale for Children-3rd Edition, and the Wechsler Individual Achievement Test. All tests were administered according to the standard procedures published for each respective test instrument administered. The CTONI and the WISC-III were administered in a counter balanced order with 50% of the participants had the CTONI administered first and the WISC-III second. The other 50% of the participants received the WISC-III first and the CTONI second. The following is a description of these tests.

The Comprehensive Test of Nonverbal Intelligence

The CTONI is a nationally standardized individually administered nonverbal measure of intelligence for individuals from ages 6-0 to 89-11. The CTONI's normative sample consists of 2,129 school-aged children closely resembling the 1990 U.S. Census data. One hundred and seven Native-American children (approximately 5.0%) are included in the normative sample. The CTONI does not require any verbal response from the student and the instructions provided to the child for each subtest contain no more than two short sentences. Additionally, a pantomime of the directions is also provided. In response, the student needs only point to one of five answer choices presented at the bottom of each page from a stimulus book. The CTONI consists of six subtests whose summed scale scores constitute the Nonverbal IQ composite score. The six subtests are designed to measure three different but interrelated nonverbal cognitive abilities through two separate presentation formats. The three cognitive abilities are analogical, categorical, and sequential reasoning. These three processing tasks are presented through two different stimulus contexts--pictorial objects and geometric designs. The three reasoning processes presented under the same stimulus context form the Pictorial Nonverbal IQ and Geometric Nonverbal IQ composite scores. The three pictorial and the three geometric subtest scale scores are combined to form the Full-scale Nonverbal IQ composite score. The six subtest scale scores (Pictorial Analogies, Pictorial Categories, Pictorial Sequences, Geometric Analogies, Geometric Categories, and Geometric Sequences) and the three nonverbal intelligence quotients (Pictorial Nonverbal IQ, Geometric Nonverbal IQ, and Nonverbal IQ) were obtained from the participants special education file and used in the data analysis.

Wechsler Intelligence Scale for Children-Third Edition

WISC-III is a comprehensive measure of cognitive abilities developed for children ranging in age from 6-0 to 16-11. The WISC-III was nationally normed on a sample of 2,200 children. The normative sample closely resembles the 1988 U.S. Census data. Three and a half percent (3.5%) of the WISC-III normative sample (approximately 77 children) is representative of Native-American children. The WISC-III is composed of 10 subtests whose scale scores are summed to form three composite scores, Verbal IQ, Performance IQ, and Full-scale IQ. The Verbal IQ score includes five subtests that require verbal responses in English. The Performance IQ score is composed of another five subtests that do not require verbal responses. Responses to the Performance subtests are made by pointing, copying, or through manual placement of test materials. The Full-scale IQ is a composite of all ten subtests from both the Verbal and Performance subtests. The three intelligence composite scores derived from the WISC-III are intended to estimate children's intellectual aptitude. The three intelligence composite scores

(Performance IQ, Verbal IQ, and Full-scale IQ) as well as the subtest scale scores that comprise the Verbal and Performance IQ scores (Information, Similarities, Arithmetic, Vocabulary, Comprehension, Picture Completion, Coding, Picture Arrangement, Block Design, and Object Assembly) were obtained from each participants' special education file for further analysis.

Wechsler Individual Achievement Test

The WIAT is a comprehensive individually administered achievement test battery that provides normative scores on the student's reading, spelling, mathematics, writing, and language achievement. It is designed for use with children from kindergarten through twelfth grade. The standardization sample of the WIAT consists of 4,252 children. This sample closely represents the 1988 U.S. Census data. Approximately 154 Native-American students (3.63%) were included in the WIAT normative sample. The WIAT Reading Composite score and Mathematics Composite scores are used in this study as measures of academic achievement. The Reading Composite score is composed of two subtests – Basic Reading and Reading Comprehension. The Basic Reading subtest requires the student to accurately read a list of words that are isolated from any semantic context. The Reading Comprehension subtest requires the student to accurately answer questions based upon short paragraphs that the student has read silently. The Mathematics Composite score consists of two subtests – Mathematics Reasoning and Numerical Operations. The Mathematics Reasoning subtest consists of oral and printed consumer mathematics problems. Many of these problems are mathematics word problems, money calculation, or time and measurement problems. The Numerical Operations subtest consists of paper and pencil arithmetic calculation problems. These arithmetic problems start with simple addition, subtraction, multiplication, and division. The Numerical Operations work sheet ends with addition and subtraction of fractions, decimal number problems, negative numbers, and basic algebra. The Reading Composite and Mathematics Composite scores for each participant were obtained from his or her special education file and were used as a measure of academic achievement.

## Hypotheses

The following hypotheses were investigated to examine the concurrent, predictive, and factorial validity of the CTONI when used with learning disabled Native-American Navajo students:

### Hypothesis 1

It was hypothesized that the CTONI IQ correlate with the WISC-III Full-scale IQ.

### Hypothesis 2

It was hypothesized that the CTONI IQ have a relationship with the WISC-III Performance IQ.

### Hypothesis 3

Given that the CTONI is a nonverbal measure of intelligence, it was hypothesized that the CTONI IQ would correlate weakly with the Verbal IQ from the WISC-III.

Hypothesis 4

It was hypothesized that the CTONI IQ is predictive of achievement as measured by the WIAT reading and mathematics composite scores.

Hypothesis 5

It was hypothesized that the factor solutions obtained for this sample based on the CTONI and the WISC-III are not significantly different from the factorial solution for each test's respective normative sample.

## Statistical Analysis of Data

Consistent with the major hypotheses, three kinds of statistical analyses were performed using Fastat statistical computer software package. The first three hypotheses investigated the concurrent validity of the CTONI IQ scores with WISC-III IQ scores. The concurrent validity was investigated by calculating the Pearson's correlation coefficient for the three CTONI IQ scores with the WISC-III IQ scores. The description for the strength of the relationship was adopted here as that defined in Herzberg (1983). A strong relationship among the test scores is defined in this study by correlation coefficients ranging from .70 to 1.00. Moderate relationships are defined by correlation coefficients ranging from .30 to .69. Correlation coefficients below .30 are considered for the purpose of this study to represent a weak relationship. The degree with which the relationships between the IQ scores were significantly correlated was determined by using a standard table for the critical values of Pearson's correlations as published in Herzberg, 1983. A critical value of .240 was used in Hypotheses 1 through 3 based upon

48 degrees of freedom and the assumption of a one tailed distribution. A z statistic was computed for the CTONI and the WISC-III IQ scores to determine if the relationship is significantly different from the median correlation coefficient between the Wechsler scales and nonverbal IQ measures taken from the literature regarding Native-American and Learning Disabled students. Table 1 presents the correlation coefficients among various nonverbal measures of intelligence and the WISC-III or the WISC-R. The studies consisted of Native-American students or Learning Disabled students thus providing a basis for comparison with the sample used in this study. The median correlation coefficients for these studies are presented in Table 1 and are used for the comparative relationship between the Wechsler intelligence scales and nonverbal measures of intelligence. Consistent with the fourth hypothesis, the predictive validity of the CTONI IQ scores and WISC-III IQ scores as estimates of reading and mathematics achievement was investigated. Two separate multiple regression equations were computed with regard to the CTONI and the WISC-III in predicting WIAT Reading and Mathematics composite scores. The first multiple regression equation included the WISC-III PIQ and VIQ and the CTONI PNIQ and GNIQ scores in predicting WIAT Reading Composite scores. The second multiple regression equation entered the WISC-III PIQ and VIQ scores and CTONI PNIQ and GNIQ as independent variables in predicting WIAT Mathematics Composite scores. The resulting squared multiple R statistics in predicting WIAT Reading and Mathematics scores based upon the CTONI

and the WISC-III were compared to determine which measure of intelligence is the better predictor of achievement.

Table 1

Correlation Coefficients Between Nonverbal Measures of Intelligence and the Wechsler Scales as Cited in the Literature

| Nonverbal IQ Tests | WISC-III / WISC-R | | | Achievement Tests | |
|---|---|---|---|---|---|
| | VIQ | PIQ | FSIQ | Math | Reading |
| CTONI NIQ[1] | .38 | .50 | .51 | .62 | .29 |
| CTONI NIQ[2] | .75 | .70 | .81 | | |
| SON-R[3] | .51 | .52 | .68 | | |
| TONI[4] | .55 | .58 | .59 | | |
| TONI[5] | .68 | .42 | .48 | | |
| TONI[6] | .61 | .81 | .87 | | |
| TONI[7] | .34 | .44 | .44 | | |
| TONI[8] | .32 | .36 | .27 | .42 | .23 |
| RCPM[9] | .55 | .62 | .67 | .55 | .16 |
| RSPM[10] | | | | .46 | .40 |
| Median Coefficient* | .55 | .55 | .63 | .46 | .23 |

[1]Present Study. [2]Hammill et al. (1997) WISC-III, learning disabled sample. [3]Curran et al. (1996) WISC-III, Native-American sample. [4]D'Amato et al. (1994) WISC-R, learning disabled sample. [5]Whorton & Morgan (1990) WISC-R, Native-American sample. [6]Kowall et al. (1990) WISC-R, Native-American learning disabled sample. [7]Haddad (1986) WISC-R, learning disabled sample. [8]Lassiter & Bardos (1992) WISC-R and K-ABC Achievement Test, learning disabled sample. [9]Kluever et al. (1995) WISC-III and WJ-R Test of Achievement, Native-American sample. [10]Sidles & MacAvoy (1987) Comprehensive Test of Basic Skills, Native-American sample.

*Data from the present study were not used in calculating these median coefficients.

Hypothesis five investigated the factorial validity of the CTONI and the factorial validity of the WISC-III for this Native-American sample. Hypothesis 5 investigated the CTONI factorial structure by entering the participants' scores from the six CTONI subtests (Pictorial Analogies, Pictorial Categories, Pictorial Sequences, Geometric Analogies, Geometric Categories, and Geometric Sequences) into a principal component analysis equation. Additionally, the WISC-III factorial structure was investigated by entering the 10 subtest scores that comprise the Verbal and the Performance IQ scores from the WISC-III (Vocabulary, Similarities, Information, Comprehension, Arithmetic, Object Assembly, Picture Arrangement, Picture Completion, Coding and, Block Design) into a principal component analysis equation. Varimax orthogonal rotation was used to simplify the factor loadings and determine a meaningful factor structure for both the CTONI and the WISC-III. The number of eigenvalues greater than 1.0 was used to determine the initial number of derived factors. Loadings greater then .40 were used to designate if a variable had loaded significantly. Differences between factor loadings for the same variable must be .15 or greater to demonstrate clear loading on a single factor. The derived factor structure for this sample of Native-American learning disabled students was compared to the factor structure provided in each tests normative manual. The coefficient of congruence was computed to determine the degree this sample's factorial structure paralleled that of the normative factor structure.

# CHAPTER 4

# RESULTS

## Results Related to Hypothesis 1

The concurrent validity of the CTONI was investigated by assessing the strength and the statistical significance of the correlations between its IQ scores with the WISC-III Performance IQ scores. The resulting correlations suggest the CTONI IQ scores demonstrate a moderate relationship with the WISC-III Full-scale IQ score for this sample of learning disabled Native-American students. The CTONI Nonverbal IQ composite score is correlated with the WISC-III Full-scale IQ score at the .51 level. This suggests that approximately 26% of the variance is accounted for by the two full-scale IQ scores. This relationship is between the CTONI NIQ and the WISC-III Full-scale IQ is significant at the .05 level. A summary of the correlation coefficients between the CTONI IQ scores and the WISC-III IQ scores is presented in Table 2.

The median correlation coefficient between nonverbal IQ measures and the Wechsler Full-scale is .63 and will be used as $Z_a$ in computing the z value comparing the CTONI and the other nonverbal intelligence measures. When the correlation between the NIQ and the FSIQ is compared with the median correlation found in the literature the resulting z value equals -1.220, which suggests that the observed correlation between the NIQ and the FSIQ is not significantly different from what is suggested in the literature. The resulting confidence interval for this relationship ranges from .27 to .69.

Table 2

Correlation Coefficients Among the IQ Composite Scores for the WISC-III, CTONI, and WIAT

| | WISC-III | | | CTONI | | | WIAT | |
|---|---|---|---|---|---|---|---|---|
| | FSIQ | PIQ | VIQ | NIQ | GNIQ | PNIQ | Reading | Math |
| FSIQ | — | | | | | | | |
| PIQ | .84* | — | | | | | | |
| VIQ | .86* | .44* | — | | | | | |
| NIQ | .51* | .50* | .38* | — | | | | |
| GNIQ | .45* | .48* | .29* | .88* | — | | | |
| PNIQ | .43* | .37* | .36* | .83* | .46* | — | | |
| Reading | .26* | .20 | .24* | .29* | .18 | .33* | — | |
| Math | .73* | .62* | .63* | .62* | .47* | .59* | .47* | — |

*significant at .05 level

The PNIQ and the GNIQ scores are moderately correlated with the WISC-III Full-scale IQ score. The Full-scale IQ from the WISC-III correlates with the PNIQ and the GNIQ .43 and .45 respectively and these correlations are significant at the .05 level. Eighteen percent of the variance is shared between the PNIQ and the FSIQ. Similarly, the GNIQ and the FSIQ have 20% common variance. Again the median correlation for the Wechsler FSIQ is .63. When the correlation between the PNIQ and the FSIQ is compared with the median correlation found in the literature the resulting z value is -1.926, which suggests that the observed correlation between the PNIQ and the FSIQ is not significantly different from the median correlation coefficient found in the literature for other nonverbal IQ measures. Based upon the 95% confidence interval the correlation ranges from .17 to .63.

Again the correlation between the GNIQ and the FSIQ does not significantly differ from the mean of .63 for other nonverbal IQ measures. The z equals -1.755 for this comparison with a 95% confidence interval ranging from .20 to .65.

Results Related to Hypothesis 2

For this sample of Native-American learning disabled students, the resulting correlations suggest that the CTONI IQ scores demonstrate a moderate relationship with the WISC-III Performance IQ. Table 2 summarizes the correlations between the CTONI and the Performance IQ. The CTONI NIQ composite score is correlated with the PIQ score at the .50 level. This suggests that approximately 25% of the variance is accounted for by these two measures of nonverbal reasoning. The relationship between the CTONI Nonverbal IQ and the Performance IQ is statistically significant at the .05 level. The median correlation between other nonverbal measures of intelligence and the Performance IQ is .55 as summarized in Table 1. The median correlation of .55 will be used as $Z_a$ in the comparison between the CTONI and other nonverbal measures of intelligence. The z value the NIQ with other nonverbal intelligence measures is -.473 suggesting that the two correlations are not significantly different. At the 95% confidence level the confidence level is between .26 and .69.

Similarly, the CTONI Pictorial Nonverbal IQ score and the Geometric Nonverbal IQ score correlated with the Performance IQ score at a moderate level with a correlation coefficient of .369 and .478 level respectively. The resulting z value for the PNIQ with the expected correlation suggested from the literature is -1.576 with a 95% confidence interval of .10 to .59. The z value for the GNIQ with the hypothesized PIQ relationship equals -.651 with a confidence interval of .24 to .67. Both the PNIQ and the GNIQ are correlated to an equal degree as are other nonverbal measures of intelligence with the PIQ.

Results Related to Hypothesis 3

Given that the CTONI is purported to be a measure of nonverbal reasoning it is expected that the CTONI IQ scores would correlate weakly with the Wechsler Verbal IQ score. However, the literature suggests that for Native-American and learning disabled students the relationship between nonverbal measures of intelligence and the Wechsler VIQ is in the moderate range. The median correlation coefficient among the studies cited in Table 1 for the VIQ with nonverbal IQ measures is .55. The CTONI composite NIQ score correlates at a moderate level (.38) with the WISC-III Verbal IQ score. The NIQ score shares approximately 14% of the same variance with the Verbal IQ from the WISC-III. The correlation between the NIQ and the VIQ is significant at the .05 level. The difference between the correlation found for this sample between the NIQ and the VIQ is not statistically significant from the median correlation between the VIQ and other nonverbal measures. A median correlation of .55 was used as $Z_a$ in computing the z value for the comparison between the CTONI and the other nonverbal measures with the Verbal IQ. The resulting z value equals -1.494 with a confidence interval of .12 to .60 at 95%.

The Pictorial Nonverbal IQ is also moderately correlated with the Verbal IQ and at .36. This correlation is significant and accounts for approximately 13% of the variance between the PNIQ score and the VIQ score. The correlation between the PNIQ and the VIQ is not significantly different from .55 as suggested by the literature for nonverbal measures and the VIQ ($z$ = -1.652, $p$ , .05, two-tailed). A confidence level of 95% for this relationship ranges between .09 and .58.

Although the CTONI Geometric Nonverbal IQ score correlated weakly with the WISC-III Verbal IQ score with a correlation coefficient of .294, the relationship is significant at the .05 level. The GNIQ score and the VIQ have only 9% common variance. The z value for the GNIQ's relationship with the VIQ as compared with the median correlation coefficient suggested in the literature for the VIQ is -2.186. This suggests that the relationship between the GNIQ and the VIQ is significantly smaller than the median correlation coefficient among other measures of nonverbal intelligence and the VIQ. This correlation coefficient has a 95% confidence interval of .02 to .53.

## Results Related to Hypothesis 4

The predictive validity of the WISC-III and the CTONI as measures of intelligence was investigated by using separate multiple regression equations for the CTONI IQ score and the WISC-III IQ scores in predicting WIAT composite scores. The mean reading and mathematics achievement for this Native-American sample of students is presented in Table 3.

Table 3

Mean, Standard Deviation, and Range of Scores for the WISC-III, CTONI, and WIAT

| Test | Mean | SD | Range |
|---|---|---|---|
| WISC Full-scale IQ | 84.34 | 9.74 | 65 - 103 |
| WISC Verbal IQ | 73.76 | 10.61 | 54 - 104 |
| WISC Performance IQ | 99.06 | 11.60 | 81 - 129 |
| CTONI Nonverbal IQ | 90.16 | 9.76 | 70 - 111 |
| CTONI Geometric Nonverbal IQ | 93.54 | 11.54 | 70 - 128 |
| CTONI Pictorial Nonverbal IQ | 88.20 | 9.71 | 70 - 113 |
| WIAT Mathematics Composite | 76.84 | 11.15 | 54 - 105 |
| WIAT Reading Composite | 68.78 | 8.76 | 45 - 85 |

The mean reading composite score is 68.78 and the mean mathematics composite score is 76.84. The students in this sample were specifically selected due to their placement into special education under the funding category of learning disabled. Thus, it is not surprising that the mean reading and mathematics achievement scores are well below the normative mean. The WISC-III FSIQ and VIQ plus the NIQ and the PNIQ from the CTONI are significantly correlated with reading achievement. Table 2 demonstrates that the significant correlations between IQ and the WIAT Reading

Composite ranges from a low of .24 for VIQ to a high of .33 for the PNIQ. The WISC-III PIQ and CTONI GNIQ are not significantly predictive of reading achievement.

It was expected that the combination of the intelligence scores would increase the prediction for reading achievement. The independent variables entered into the multiple regression equation were the following: WISC-III Performance IQ, Verbal IQ, CTONI Pictorial Nonverbal IQ, and Geometric Nonverbal IQ. The dependent variable for the first multiple regression equation was WIAT Reading Composite scores. The results from the multiple regression equation for reading suggest that none of the independent variables in combination were significant predictors of the WIAT Reading Composite for this sample of Native-American students. Table 4 illustrates the multiple regression equation results for the Reading Composite. The multiple correlation coefficient for this regression equation is .354.

Table 4

Multiple Regression Results in Predicting WIAT Reading Composite Scores

Dependent Variable: WIAT Reading Composite

| Variable | Regression Coefficient | Standard Error | β Coefficient | Tolerance | t | p (2 tail) |
|---|---|---|---|---|---|---|
| PIQ | .037 | .129 | .049 | .664 | .287 | .776 |
| VIQ | .106 | .132 | .129 | .758 | .805 | .425 |
| GNIQ | -.003 | .129 | -.004 | .676 | -.024 | .981 |
| PNIQ | .236 | .148 | .262 | .722 | 1.596 | .118 |

Sample Size: 50 Multiple R: .354 Squared Multiple R: .126 Std. E of Est.: 8.546

The Reading Composite scores are positively correlated at a weak level with the CTONI and WISC-III IQ scores. The multiple $R^2$ equals .126. When taken together the four intelligence test scores only account for 12.6% of the variance in the reading composite scores. Since the combination of the IQ scores did not significantly improve predictions for reading achievement over the individual IQ tests alone further multiple regression analyses between the WISC-III and the CTONI is unwarranted. A comparison between the correlation between WISC-III FSIQ with reading achievement and the correlation between the CTONI NIQ and reading achievement suggests that the two measures are equal in predicting WIAT reading composite scores ($z = .226$, $p < .05$, two-tailed).

The mathematics results suggest that the WISC-III VIQ and PIQ and the CTONI PNIQ are significant predictors of mathematics achievement (the CTONI GNIQ did not significantly predict mathematics composite scores for this sample of Native-American learning disabled students). The resulting multiple correlation coefficient equals .801. The squared multiple correlation suggests that the independent variables account for 64.1% of the shared variance with the mathematics composite scores. Table 5 summarizes the results. The analysis of variance indicates that both the CTONI and the WISC-III IQ scores are statistically significant predictors of mathematics achievement, $F(4, 45) = 20.10$, $p = .000$. The Mathematics Composite scores are positively correlated at a moderate level with the PIQ, VIQ, PNIQ, and GNIQ.

Table 5

Multiple Regression Results in Predicting WIAT Mathematics Composite Scores

Dependent Variable: WIAT Mathematics Composite

| Variable | Regression Coefficient | Standard Error | β Coefficient | Tolerance | t | p (2 tail) |
|---|---|---|---|---|---|---|
| PIQ | .303 | .105 | .315 | .664 | 2.872 | .006 |
| VIQ | .374 | .108 | .356 | .758 | 3.469 | .001 |
| GNIQ | .071 | .105 | .074 | .676 | .680 | .500 |
| PNIQ | .360 | .121 | .313 | .722 | 2.979 | .005 |

Sample Size: 50 Multiple R: .801 Squared Multiple R: .641 Std. E of Est.: 6.972

A multiple regression equation was computed with only the CTONI PNIQ and GNIQ entered in as independent variables predicting WIAT Mathematics Composite scores. The resulting multiple $R^2$ suggests that the CTONI IQ scores share approximately 40.2% of the variance with the mathematics composite scores. Table 6 summarizes the multiple regression results.

Table 6

Multiple Regression Results for CTONI IQ Scores in Predicting
WIAT Mathematics Composite Scores

Dependent Variable: WIAT Mathematics Composite

| Variable | Regression Coefficient | Standard Error | β Coefficient | Tolerance | t | p (2 tail) |
|---|---|---|---|---|---|---|
| GNIQ | .246 | .123 | .254 | .785 | 1.998 | .052 |
| PNIQ | .545 | .146 | .475 | .785 | 3.730 | .001 |

Sample Size: 50 Multiple R: .634 Squared Multiple R: .402 Std. E of Est.: 8.807

The squared multiple correlation for the full regression equation with WISC-III and CTONI was compared with the multiple $R^2$ for the CTONI scores alone. The resulting F ratio calculated for the difference between the two multiple $R^2$s suggests that the CTONI IQ scores are contributing significantly to the overall prediction of mathematics achievement $\underline{F}(2, 45) = 14.98$, $p = .05$.

Table 7 illustrates the multiple regression equation for WISC-III PIQ and VIQ in predicting WIAT Mathematics Composite scores. The results suggest that the Wechsler IQ scores are significant predictors of mathematics achievement $\underline{F}(2, 47) = 28.12$, $p = .000$. The multiple squared correlation suggests that 54.5% of the variance is shared by the Wechsler IQ scores and the Mathematics Composite scores.

Table 7

Multiple Regression Results for WISC-III IQ Scores in Predicting
WIAT Mathematics Composite Scores

Dependent Variable: WIAT Mathematics Composite

| Variable | Regression Coefficient | Standard Error | β Coefficient | Tolerance | t | p (2 tail) |
|---|---|---|---|---|---|---|
| PIQ | .411 | .105 | .428 | .804 | 3.899 | .000 |
| VIQ | .464 | .115 | .441 | .804 | 4.018 | .000 |

Sample Size: 50 Multiple R: .738 Squared Multiple R: .545 Std. E of Est.: 7.683

A z score was calculated to determine if the difference between the predicted varience for the CTONI and the WISC-III is significantly different. The multiple correlation coefficients for the regression equations containing only the CTONI IQ and only the WISC-III IQ for predicting WIAT Mathematics Composite scores was not significantly different from each other. The Wechsler IQ and the CTONI IQ are equal in their predictive validity for mathematics achievement ($z = 1.133$, $p < .05$, two-tailed).

## Results Related to Hypothesis 5

Factorial validity in part relates to the degree to which the underlying traits of a test are in conformity with the characteristics that a test is designed to measure. The CTONI Manual proposes that the six subtests of the CTONI load on a single factor and that such a factor is a measure of general nonverbal intellectual ability (Hammill et al., 1997). Not only does the CTONI Manual state the CTONI is represented by a single factor but it also suggests that the single factor solution is descriptive for the American-Indian sample included in the normative sample.

For this learning disabled Native-American sample a principal component analysis was conducted on the six CTONI subtests. The results of this principal components analysis are presented in Table 8. The number of factors to be rotated was first determined by the number of eigenvalues greater than 1.0. A two-factor solution resulted from this analysis. Factor one has an eigenvalue of 2.58 and this factor accounts for 42.96% of the variance. Factor two has an eigenvalue of 1.07 and accounts for 17.78% of the variance. The two-factor solution accounts for approximately 60.74% of the total variance. However, the two- factor solution is not easily interpretable. Factor one consists of the three Geometric Nonverbal subtests (Geometric Analogies, Geometric Categories, and Geometric Sequences). The second factor consists of two of the Pictorial Nonverbal subtests (Pictorial Analogies and Pictorial Categories).

TABLE 8.

CTONI Two Factor Varimax Rotated Solution
With Eigenvalues Greater Than One

| Subtest | Factor I | Factor II |
|---|---|---|
| GA | .81* | .02 |
| GC | .78* | .08 |
| GS | .64* | .45 |
| PS | .50 | .44 |
| PA | .08 | .88* |
| PC | .12 | .73* |
| Eigenvalue | 2.58 | 1.07 |
| Variance | 42.96 | 17.78 |

The Pictorial Sequences subtest loaded equally on both factors. The results from this principal components analysis tends to suggest that the CTONI may consist of a geometric nonverbal factor and a pictorial nonverbal factor. Although the principle for extracting initial factors for the two-factor solution was based upon the number of eigenvalues greater than one, the postulate of parsimony suggests that a more simple factor structure may produce a more interpretable factor solution. The single factor solution is presented in Table 9. All of the variables produced moderate to high loadings on the single factor. The single factor accounts for 42.96% of the variance. The single factor solution is interpretable and suggests that the CTONI is a unitary measure of nonverbal intellectual reasoning.

Table 9

Study Sample and Normative Sample Single Factor Solution With Varimax Rotation For The CTONI

| Subtest | Study Sample | Normative Sample |
|---|---|---|
| GS | .78 | .71 |
| PS | .67 | .68 |
| GC | .65 | .54 |
| PA | .63 | .57 |
| GA | .63 | .66 |
| PC | .56 | .50 |
| Eigenvalue | 2.58 | |
| % Variance | 42.96 | |
| Coefficient of Congruence | | .997 |

The validity of the single factor solution for the CTONI was supported by calculating the coefficient of congruence between the single factor solution presented in the CTONI manual and the single factor loading for this sample. The coefficient of congruence for the normative factor loadings with this learning disabled Native-American sample is .997.

A principal component analysis was performed to determine if the construct validity for the WISC-III with this sample of Native-American students is consistent with the underlying traits reflected by the factorial model reported for the normative sample. The WISC-III subtests entered into the equation were only those subtests used to compute the Verbal, Performance and Full-scale IQ scores (Comprehension, Similarities, Information, Vocabulary, Arithmetic, Block Design, Object Assembly, Coding, Picture Completing, and Picture Arrangement). The literature suggests that these ten subtests form a two-factor solution represented by the Verbal IQ subtests (Comprehension, Similarities, Information, Vocabulary, Arithmetic) forming one factor and the Performance IQ subtests (Block Design, Object Assembly, Coding, Picture Completion, and Picture Arrangement) forming the second factor. The first factor contains the Verbal IQ subtests (Comprehension, Similarities, Information, Vocabulary, and Arithmetic). Factor one accounts for 34.49% of the variance. The second factor accounts for 14.8% of the remaining variance and consists of the following Performance IQ subtests (Object Assembly, Coding, and Picture Completion). The Block Design and Picture Arrangement subtests loaded equally on the two factors. Table 10 summarizes the principal component analysis for this sample of Native-American students. The validity of the two-factor solution for the WISC-III is partially supported by calculating the coefficient of congruence between the two-factor solution presented in the WISC-III manual and the two- factor solution for this sample. The coefficient of congruence for the normative sample's first factor loadings and the Native-American student sample first factor loadings is .96. Suggesting the Verbal IQ factor for Native-American students and the normative sample are consistent. The loadings on the second factor for the normative sample and the Native-American student sample have a coefficient of congruence of .87. This is relatively low for a coefficient of congruence. Taken with the

TABLE 10

Study Sample And Normative Sample Two Factor Solution With Varimax Rotation For The WISC-III

| Subtest | Study Factor I | Normative Factor I | Study Factor II | Normative Factor II |
|---|---|---|---|---|
| Comprehension | .80* | .68* | -.19 | .24 |
| Similarities | .78* | .75* | .08 | .29 |
| Information | .70* | .76* | .31 | .30 |
| Vocabulary | .66* | .81* | .29 | .26 |
| Arithmetic | .56* | .56* | .04 | .42 |
| Object Assembly | .05 | .28 | .77* | .66* |
| Coding | .01 | .17 | .60* | .39* |
| Picture Completion | .07 | .39 | .58* | .50* |
| Picture Arrangement | .42 | .34 | .54 | .43* |
| Block Design | .51 | .35 | .44 | .72* |
| Eigenvalue | 3.45 | | 1.48 | |
| % Variance | 34.49 | | 14.8 | |
| Coefficient of Congruence | | .96 | | .87 |

nonsignificant loadings for the Block Design and the Picture Arrangement, it would appear the Performance IQ factor for this sample of Native-American students is not consistent with the normative sample.

Additional Findings

The relationship between the WISC-III IQ scores and the CTONI IQ scores were investigated with descriptive statistics. The mean, standard deviation (SD), and range of scores for the three tests are presented in Table 3. The average WISC-III IQ scores for the Native-American students in this study range from a high of 99.06 for the Performance IQ to a low of 73.76 for the Verbal IQ. The average Full-scale IQ is 84.34 for this group of students. This suggests considerable variability among the participant's WISC-III IQ test scores. Qualitatively, this suggests that the mean Performance IQ score for this sample of learning disabled Native-American students is in the Average ability range but the mean Verbal IQ score is in the Borderline range of intellectual ability. The difference between the sample's Verbal IQ and Performance IQ scores ranged from 2 points to 57 points with a mean difference of 25.3 points with a standard deviation of 11.76 points. According to the WISC-III manual an 11-point difference between the Verbal IQ score and the Performance IQ score is considered statistically significant. Ninety-eight percent of this sample of Native-American students demonstrated an 11-point or greater difference between their Verbal IQ score and their Performance IQ score. The majority of the Verbal IQ scores (98%) are consistently lower than the Performance IQ score.

The average CTONI IQ scores for this sample range from a high of 93.54 for the Geometric Nonverbal IQ to a low of 88.20 for the Pictorial Nonverbal IQ. The average score for the composite Nonverbal IQ is 90.16 with a standard deviation of 9.76 points. Qualitatively, this suggests that the mean CTONI IQ scores for the Native-American students in this study received average to low average IQ score scores with respect to their Geometric Nonverbal and Pictorial Nonverbal IQ scores. The Native-American students in this study did not demonstrate as much variability between their CTONI IQ score scores as they did on the WISC-III IQ scores. The difference between the Geometric Nonverbal score and Pictorial Nonverbal score ranged from 0 to 41 points -- mean difference equal to 5.34 points and a standard deviation of 11.12 points. Approximately half of the students scored higher on the Geometric Nonverbal IQ score 58% as did the students who scored higher on the Pictorial Nonverbal IQ score 42%. The CTONI manual states that Geometric Nonverbal IQ and Pictorial Nonverbal IQ score differences of 10 points are considered significant. Fourty-two percent of the participants demonstrated a 10-point difference between their Geometric Nonverbal IQ score and their Pictorial Nonverbal IQ score. Although a 10-point difference between the two scores is considered statistically significant the CTONI Manual recommends that a 15-point difference should be considered clinically significant. Twenty-four percent of the sample demonstrated a 15-point or more difference between the CTONI Pictorial IQ and Geometric IQ scores.

The mean difference between the WISC-III Full-scale and the CTONI composite Nonverbal IQ score for this sample of Native-American students is 5.82 points with a standard deviation of 9.66. The difference between the two composite IQ scores ranged from 0 to 31 points. The CTONI Manual states that an 9-point difference between the CTONI Nonverbal IQ score and the WISC-III Full-scale IQ score is considered significant. Fourty-six percent of the sample of students demonstrated composite IQ score differences equal to or grater than 9 points.

# CHAPTER 5

# DISCUSSION

The results related to the first hypothesis support that the CTONI IQ scores are correlated significantly with the WISC-III Full-scale IQ. The CTONI IQ scores demonstrated moderate relationship with the FSIQ for this sample of learning disabled Native-American students. D'Amato et al. (1994), Haddad (1986), Kluever et al. (1995), and Whorton and Morgan (1990) suggest that the relationship between matrix reasoning tests and the Wechsler FSIQ are in the moderate range for Native-American and learning disabled populations. However, Hammill et al. (1997) and Kowall et al. (1990) would suggest that this relationship is stronger. Comparisons between the strength of the relationship found for the CTONI IQ scores and the WISC-III FSIQ in this study are consistent with the median correlation coefficient for the FSIQ and other nonverbal measures of intelligence.

The results related to the second hypothesis suggest that a moderate but significant relationship exists between the CTONI IQ scores and the WISC-III Performance IQ score. Since it was proposed that a significant relationship would exist between these two measures of nonverbal reasoning Hypothesis 2 was supported. The results from this study with regard to the magnitude of the relationship between the CTONI and the Performance IQ are consistent with other studies comparing matrix reasoning tests with the Wechsler Performance IQ. Kluever et al. (1995) found moderate relationship between the Raven's Coloured Progressive Matrices and the WISC-III

Performance IQ for students suspected of having a learning disability. Similarly, D'Amato et al. (1994), Haddad (1986), and Lassiter and Bardos (1992) found moderate correlations between the TONI and the WISC-R Performance IQ for learning disabled students. Whorton and Morgan (1990) found moderate correlations between the TONI and the WISC-R Performance IQ for Native American Students. However, Kowall et al. (1990) reported a strong relationship between the TONI and the WISC-R Performance IQ for a Native American sample. Although the SON-R is not strictly a matrix reasoning test it is a non-verbal measure of intellectual functioning. Curran et al. (1996) found that the SON-R correlated moderately with the WISC-III Performance IQ for a sample of Native-American students. Comparisons between the median correlation coefficient for nonverbal measures of intelligence and the PIQ and the moderate correlations found in this study are not significantly different. Thus, the moderate relationship found in this study between the CTONI and the WISC-III Performance IQ is consistent with the results cited in the literature.

The results of this study with regard to Hypothesis 3. suggest that the relationship between the CTONI and the WISC-III Verbal IQ score is generally in the moderate range. Given that the CTONI is a nonverbal measure of intelligence it was hypothesized that it would correlate weakly with the Verbal IQ. The results suggest that Hypothesis 3 was not supported. Nevertheless, the results from this study are consistent with the literature for nonverbal intelligence measures compared with the Wechsler Verbal IQ. Curran et al. (1996) and Kluever et al. (1990) respectively found moderate relationships between the SON-R and the RCPM and the WISC-III Verbal IQ. Similarly, D'Amato et al. (1994), Haddad (1986), Kowall et al. (1990), Lassiter and Bardos (1992), and Whorton and Morgan (1990) found the TONI and the WISC-R Verbal IQ to be moderately correlated. The NIQ and PNIQ correlated at .38 and .36 respectively with the VIQ. The strength of these relationships are not significantly different from the median correlation for nonverbal intelligence tests with the Wechsler Verbal IQ. However, the GNIQ correlated weakly with the VIQ. The GNIQ score was found to be significantly lower than the median correlation suggested by the literature. Thus, Hypothesis 3 is partially supported by the results relative to the CTONI GNIQ.

Lassiter and Bardos (1992) suggest that it is more appropriate to argue against the verbal/nonverbal dichotomy when describing human intellectual functioning because it does not serve our understanding of learning. D'Amato et al. (1994) and Lassiter and Bardos (1992) argue that matrix reasoning tests should be regarded as measures of simultaneous information processing rather than nonverbal measures of intelligence. Kowall et al. (1990) suggest that such tests are measures of visual organization and problem solving. Given the results from this study with regard to the moderate correlations between the CTONI NIQ and PNIQ with the WISC-III Verbal IQ and the weak correlation for the GNIQ with the VIQ, caution should be exercised in interpreting the CTONI as strictly a nonverbal measure of intelligence. It is reasonable to expect that the CTONI assesses other reasoning skills beyond the verbal/nonverbal dichotomy for Native-American students.

The results for Hypothesis 4 partially supported the expectation that the CTONI would be a significant predictor of academic achievement. Generally, the correlations for the CTONI and the WISC-III with the WIAT Reading Composite are small and only account for 3 to 11 percent of the common variance. The CTONI NIQ and PNIQ were significantly correlated with the WIAT Reading Composite at .29 and .33 respectively. The FSIQ and VIQ from the WISC-III were significantly correlated with the WIAT Reading Composite at .26 and .24. The CTONI NIQ and WISC-III FSIQ are not significantly different in their prediction of reading achievement. Furthermore, the prediction of reading achievement is not enhanced by the combined effects of the VIQ, PIQ, GNIQ, and PNIQ. In combination the multiple correlation was found not to be significant in predicting WIAT Reading Composite scores. The results suggest that reading achievement is weakly related to the skills measured by the CTONI and the WISC-III for this sample of students.

The literature regarding predicting Native American Navajo students' reading achievement based upon intelligence scores is inconsistent. Mishra and Lord (1982) suggest that neither the WISC-R Verbal nor the Performance scores are predictive of WRAT reading achievement. However, Atkinson (1993) suggests that both of the Verbal IQ and Performance IQ scores from the WISC-III are good predictors of WIAT reading achievement score. McCullough et al. (1985) suggest that only the Verbal IQ and Full-scale IQ are predictive of PIAT reading scores.

This study is consistent with the results found in McCullough et al. (1985) and Mishra and Lord (1982) in that the Wechsler Performance IQ score is a poor predictor for reading achievement among Native American students. Yet, the FSIQ and VIQ are significant predictors of reading but account for a small percentage of variance in reading for Native-American students. The literature regarding nonverbal measures of intelligence and reading achievement is inconsistent. Kluever et al. (1995), and Lassiter and Bardos (1992) found relationship between reading and nonverbal matrix reasoning intelligence tests to be nonsignificant. Sidles and McAvoy (1987), however, suggest that the relationship between matrix reasoning tests and reading achievement is in the moderate range. The CTONI was inconsistent in predicting reading achievement for Native-American students. Reading is significantly correlated with the NIQ and PNIQ but not the GNIQ. Caution should be used when using the WISC-III and the CTONI in reading disability evaluations for Native-American students.

Yet, the CTONI and the WISC-III were found to be significantly predictive of mathematics achievement as measured by the WIAT for this sample of learning disabled Native-American students. All of the CTONI and the WISC-III IQ scores were significantly correlated at a moderate level with the WIAT Mathematics Composite score. Comparisons between the multiple correlation coefficients suggest both the CTONI and the WISC-III are equally predictive of mathematics achievement. Hypothesis 4 is partially supported with regard to mathematics achievement only.

It is beyond the scope of this study to ascertain why the CTONI and the WISC-III accounted for less than 11% of the variance in reading achievement. A possibility for the weak correlations between the intelligence measures and reading achievement may be due to restriction in the range of the reading scores. The mean, standard deviation, and range of scores are presented in Table 3. The range of scores for the Reading Composite are more restricted than for the Mathematics Composite. It is possible that the correlations between the intelligence scores and reading are attenuated due to restriction in range. Further, research into the difficulty in predicting reading achievement among Native-American students is recommended.

Consistent with Hypothesis 5, this study supports the factorial validity proposed by the CTONI test authors. A single factor structure for this sample of Native American Navajo students was determined to best represent the data. The congruence between the normative sample factor structure and this study's factor structure is very strong. The construct that the CTONI is global nonverbal intelligence test appears to be a reasonable assumption when applied to Native American learning disabled Navajo students. Additionally, the results suggest that the CTONI is measuring the same intellectual traits for this sample of Native-Americans as it does for the normative sample.

Although this single factor solution is supported by this study further evaluation of the CTONI's factorial validity is warranted. The emergence of a two factor structure consisting of Pictorial IQ factor and a Geometric IQ factor may result from investigations with larger sample sizes or that include participants from more diverse backgrounds.

The factorial validity for the WISC-III for this sample of Native American Navajo students appears to support the two factor Verbal IQ and Performance IQ scores reported by the WISC-III authors. The coefficient of congruence for the WISC-III two factor solution was strong for the VIQ factor. However, ;the PIQ factor obtained a coefficient of congruence of only .87. The constructs proposed by the WISC-III manual are generally supported. This conclusion is not without interpretive difficulties. The Block Design and Picture Arrangement subtests from the WISC-III loaded equally on both factors. The Block Design is the highest loading subtest for the second factor from the normative sample but in this sample of Native American Navajo learning disabled students it produced moderate loadings on both factors. The Picture Arrangement subtest loaded equally on the VIQ and the PIQ factors both in this study and in the normative sample. Further investigations into the factorial validity of the WISC-III with Native American samples are warranted.

The additional findings are consistent with the literature regarding Native-American students demonstrating better performance on measures of nonverbal intelligence than on measures of verbal intelligence. Native-American students in this sample demonstrated markedly lower WISC-III Verbal IQ scores relative to their Performance IQ scores or their CTONI Nonverbal IQ. This trend would suggest that the Full-scale IQ from the WISC-III does not adequately summarize the intellectual abilities of Native-American Navajo students. The CTONI demonstrated less variability between the Pictorial Nonverbal IQ and the Geometric Nonverbal IQ. Thus, the composite

Nonverbal IQ score from the CTONI may be a good summary of Native-American Navajo students' nonverbal intellectual abilities.

The overall results of this study suggest that the CTONI is a useful and valid measure of intellectual reasoning for use with Native American students who are referred for special education evaluation. Given the legislative mandate for intellectual assessments that have limited language and cultural content, it would appear that the CTONI is an intelligence test that has comparable validity to the WISC-III when applied to Native American Navajo students. If the results from this study are supported by further investigations, then the CTONI may be a very useful intellectual measure when conducting special education evaluations with minority students. The validity of the CTONI is further bolstered by the fact it is relatively inexpensive, it is easy to administer and score, and it does not require very long time to administer. However, caution should be applied when generalizing the validity of the CTONI. The very limited independent research into the validity of the CTONI exists in the literature. Further investigations into the validity with various populations are necessary before the CTONI's validity as a intellectual measure for special education evaluations can be established.

# APPENDIX A

## PARENTAL CONSENT FORM

### *Non-Verbal Intelligence: A Comparison between the CTONI and the WISC-3*

I am being asked to read the following material to ensure that I am informed of the nature of this research study and of how my child will participate in it, if I consent to do so. Signing this form will indicate that I have been so informed and that I give my consent. Federal regulations require written informed consent prior to participation in this research study so that I can know the nature and risks of participation and can decide to participate or not to participate in a free and informed manner.

**Purpose:**

You are being invited to give consent for your child to participate in the above titled research project. The purpose of this project is to look at the way a new measure of intelligence, the Comprehensive Test of Nonverbal Intelligence, is able to accurately measure the intelligence of Native-American children. All too often assumptions are made about the thinking abilities of Native-Americans without doing detailed research. The purpose of this study is to find out if this new intelligence measure is a good tool to use with Navajo children who have been identified as learning disabled. This intelligence test will be compared with the most commonly used intelligence test, the Wechsler Intelligence Scale for Children 3rd Edition.

**Selection Criteria**

Your child is invited to participate in this study because he or she has been previously identified as a student with a learning disability and is from the Navajo cultural background. Approximately 50 students are being invited to participate in this study.

Your child's school day will not be affected by agreeing or disagreeing to participate in this study. The school will provide your child with the same regular education opportunities as students who were not asked to participate in this study. Your child's special education curriculum will continue as described in his or her Individual Education Program.

**Procedures:**

If you and your child agree to participate, you will be asked to consent to the following: to allow the principal investigator to copy test scores from your child's special education file. The tests in question have already been administered to your child as part of his or her special education evaluation and no additional time is required from your child's school day. If you agree to participate the following test scores will be copied from your child's special education folder: WISC-3 scale scores and IQ scores, CTONI scale scores and IQ scores, and WIAT achievement test scores. Your child's test scores will be combined with other children's test scores to generate statistical results and your child's name not be included with the scores so as to keep his/her name in confidence. The final results of this study will be reported in a doctoral dissertation at the University of Arizona. Additionally, since the requested test scores will come from your child's school record, it will not be interrupting your child's day at school. Your child's special education services will not be changed due to this project.

**Risks:**

There are no foreseeable risks to your child.

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**Benefits:**

The potential benefit from this project to your child is that it will provide Page Special Education teachers additional information about how Navajo children think and solve problems. This is very important since most of the special education teachers are not Navajo. The potential benefits of this project to the Page School District will be to see if the CTONI is a better way to test Native-American children's intelligence.

**Confidentiality:**

All test information will be kept confidential. Your child's test scores as part of his/her Special Education file will continue to have the high level of confidentiality required by law. Only the test scores your child received will be copied for the purpose of this study. During the collection of this information only the school psychologist (Michael Atkinson) and the principal investigator (Mark Wiseley) who administered the tests earlier in the year will copy the scores for the purpose of this study. You have the right to review these test scores before giving consent. Please call Mark C. Wiseley at (520) 908-1256 for answers to your questions or to discuss any concerns you may have. If you have any questions concerning your child's rights as research subject, you may call the Human Subjects Committee Office at 626-672.

**Authorization:**

Before giving my consent by signing this form, the methods, inconveniences, risks and benefits have been explained to me and my questions have been answered. I understand that I may ask questions at any time and that I am free to withdraw my child from the project at any time without causing bad feelings or affecting his or her education. New information developed during the course of this study, which may affect my willingness for my child to continue in this research project will be given to me, as it becomes available. I understand that this consent form will be filed in an area designated by the Human Subjects Committee with access restricted to the principal investigator, Mark C. Wiseley, or authorized representative of the Educational Psychology Department of the University of Arizona. I understand that I do not give up any of my legal rights by signing this form. A copy of this signed consent form will be given to me.

**Investigator's Affidavit:**

I have carefully explained to the parent or legal guardian of the subject the nature of the above project. I hereby certify that to the best of my knowledge the person who is signing this consent form understands clearly the nature, demands, benefits, and risks involved in his/her child's participation and his/her signature is legally valid. A medical problem or language or educational barrier has not precluded this understanding.

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If you agree to participate in this research project, please sign and return this entire document to your child's teacher or to: *Education Services, Page School District, PO Box 1927, Page, AZ 86040.*
A photo copy of this consent form will be sent back to you. Your participation will be greatly appreciated.
Thank You.

Student's Name (print) ______________________________

Parent Signature ___________________________________ Date ___________

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