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Effects of Time of Day on Executive Function in native American Children and Non-Native American Children

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EFFECTS OF TIME OF DAY ON EXECUTIVE FUNCTION IN NATIVE AMERICAN CHILDREN AND NON-NATIVE AMERICAN CHILDREN

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ABSTRACT

Previous research has examined the performance of Native American children on cognitive tasks. The results from these studies indicated that Native American children performed poorer on these tests than Caucasian children, especially on the Verbal IQ scale. Research on cognitive tasks have found that time of day affects performance. One area of cognitive function, not yet examined for susceptibility to circadian influence, is that of executive functioning. The present study examined the effects of time of day on executive functioning in Native American children and Non-Native American children. The study sample consisted of thirty Native American children and fifty-four Caucasian children, between the ages of 7 and 13. The children were administered four different executive measures either at 8am or 3pm.

The results indicated that there were group differences on the executive functioning tasks, where the Caucasian children performed better than the Native American children. Also, there were time of day differences, where the children tested in the afternoon performed better on the executive function tasks than the children tested in the morning. Future work in this area needs to obtain family social economic status and assess acculturation of the Native American children.

CHAPTER 1

INTRODUCTION

A number of author's have noted a lack of research examining cognitive abilities in Native Americans (Ferraro et al, 2002). Ferraro et al (2002) suggest a number of reasons for this lack of research, including distrust of non-Native researchers by Native Americans, along with Native Americans questioning the motives of non-Native researchers.

Previous research has examined the performance of Native Americans on intelligence tests. Mishra (1982) compared the performance of Navajo children to Anglo children on several subtests of the Wechsler Intelligence Scale for Children – Revised (WISC-R), when the groups were matched on the Full Scale IQ. Both the Anglo and Navajo children came from families with a low socioeconomic status. All the participants were administered all the subtests from the WISC-R. The authors argued that if the two groups were matched on Full Scale IQ then any differences between groups in performance on specific items must be due to cultural bias. Mishra hypothesized that Vocabulary, Information, and Similarities subtests were more culturally biased than the other subtests from the WISC-R. Of the 77 items on the Vocabulary, Information, and Similarities subtests, the Navajo children performed significantly worse on 15 items than the Anglo children. The authors cautioned against generalizing these results to other Native American children from different regions and tribes, since there is likely wide differences in patterns of performance between the tribes. Also, they stressed that one should use caution when interpreting the results because the participants in Mishra (1982) study came from low socioeconomic status.

McCullough, Walker, and Diessner (1985) administered the Wechsler scales to assess Native Americans from the Columbia River Basin. Seventy-five Native Americans, ranging from 12 years old to 19 years old, participated in the study. The participants were students from a tribally-operated, private school that was located on a Pacific Northwest reservation. Three of the participants were labeled with a learning disability. The participants mostly were members of the Confederated Tribes and Bands of the Yakima Indian Nation.

The participants, during the elementary school years, attended public schools. Also, all participants spoke English. Forty-two of the participants were below the age of 16 years old and were administered the WISC-R. Thirty-three participants, whom were between the ages 16 and 19 were administered the WAIS. Of those who were administered the WISC-R, 21 were female and 21 were male. On the WAIS, 73% were male and 27% were female. The results showed that the Native Americans performed at the normative mean or above on the Performance IQ scale and performed significantly below the normative mean on the Verbal IQ scale. Additionally, a measure of reading achievement was significantly correlated with the Full IQ scale and the Verbal IQ scale scores. However, the Full IQ scale did not correlate with the measure on math achievement ($r = .04$). The Verbal IQ scale had a small correlation with achievement in math ($r = .38$), and the Performance IQ scale was inversely correlated ($r = -.41$) with math achievement.

McShane and Plas (1982) studied the performance of 142 Ojibwa Native American children. The children's ages ranged from 4.5 to 16 years old. The children were referred for testing. Twenty children had problems with learning as a result of suspected otitis media, seventeen children were gifted or had high potential, and 150 children were referred for educational difficulties. The children were divided into traditional group or an acculturated group depending on their Verbal-Performance IQ. If there was less than an 8 point difference between the Verbal IQ and the Performance IQ, the child was placed in the acculturated group. If the difference was 9 points or greater, the child was placed in the traditional group. Previous work indicated that Native Americans demonstrated a pattern of performance in which they scored higher on tests of Spatial ability and lower on tests of Verbal Skills and Acquired Knowledge. The authors found that the pattern of Bannatyne scores of Spatial > Sequential > Verbal Conceptualization and Acquired Knowledge typically found in groups of Native Americans was exhibited in the traditional children, but not in the acculturated group. They suggested that further research is needed to examine the relationship between the Bannatyne scores and the Verbal/Performance IQ discrepancies.

Hale, Raymond, and Gajar (1982) examined the relationship between academic achievement and Verbal IQ for two different socioeconomic status (SES) groups on the WISC-R. Children were labeled as either low or middle class according to the Hollingshead Index of Social Position. A regression line was computed for each SES group with Verbal IQ scores predicting achievement scores. If the slope of the line (i.e. strength of the relationship) was different for the two groups, the test was judged as biased. One hundred, forty-four children, in special education classes, between the ages from 7 to 12, participated in the study. The participants were labeled as learning disabled, mentally retarded, or emotionally disturbed. The results showed that when using the WISC-R Verbal IQ score as the predictor, the low and middle SES groups' regression lines were not significantly different for predicting reading scores. This suggests that across SES groups, the Verbal IQ score from the WISC-R is a non-biased predictor of reading, when bias is defined by regression lines that are significantly different.

Beiser and Gotowiec (2000) compared 234 non-Native American children and 691 Native American children on the Performance and Verbal IQ scores of the WISC-R. The children were in Grades 2, 3, or 4. The results showed that Native American children scored significantly lower than non-Native American children on the Verbal IQ.

The results also found that a high percentage of the variability between the groups was related to factors such as health, socioeconomic status, parental attitudes toward school and cultural separation, and English language skills, especially in the Native children as compared to the non-Native children.

Issues, related to the assessment of Native American children, were discussed by Dauphinais and King (1992). The authors reviewed the literature on personality and psychoeducational assessment of Native American children. They also examined historical, sociocultural, and psychosocial perspectives of Native Americans. The authors found that the culture of Native American children is often not taken into consideration during the assessment process. Also, many of the measures used for assessment are not tested for reliability and validity on Native American children. The authors concluded that these findings can cause problems with psychologically assessing Native American children and Native Americans as a group.

One recent study took a number of steps to reduce bias when testing Native Americans. Ferraro et al. (2002) compared the performance of elderly Native Americans to elderly Euro-Americans on a short neuropsychological test battery. Thirty Euro-American and fifty-one enrolled Native Americans from a North-Central North Dakota tribe participated in the study. The European Americans were recruited from areas surrounding the reservation. They were divided by age: 60-69, 70-79, and 80-89. The participants were administered the Vocabulary and Digit Symbol subscales from the Wechsler Adult Intelligence Scale-Revised (WAIS-R), Boston Naming Test, and the Logical Memory subtest of the Wechsler Memory Scale (immediate and delayed). There was a main effect for age on the WAIS-R Vocabulary Subscale, such that performance on the subscale increased from ages 60-69 to 70-79, and then decreased for the participants aged 80-89. No main effect for Group or interaction was found. No main effect for Group or Age was found on the WAIS-R Digit Symbol Subscale. There was no main effect for Group or Age on the Boston Naming Test and no interaction. On the Logical Memory Test (Immediate and Delayed) there was no main effect for Group. However, there was a main effect for age, in which performance increased from ages 60-69 to 70-79 and then decreased from 80-89. No interaction was found. The Native Americans performed as well as the Euro-Americans. However, the authors stressed that these results cannot be applied to other Native American tribes because there are cultural differences between tribes.

The above research summarized research that examined cognitive performance in Native Americans and factors that moderate performance levels. It appears that health, socioeconomic status, acculturation, and English language skills all influence cognitive performance in Native Americans.

Research has shown that there are factors, such as age, gender, and time of day, that moderate cognitive performance in Caucasians. Recent studies have examined individual differences in children that influence vigilance performance. Lin, Hsiao, and Chen (1999) studied how CPT performance was affected by gender and age in children. In the study, 226 children ages from 6-13 years old and 115 children aged 13-15 years old participated. The children were administered a CPT test in which numbers from 0 to 9 randomly appeared on the computer screen about every second. Children were instructed to press a button when a target stimulus appeared, which was defined as a 1 followed by a 9. There were two parts to the CPT test, an ungraded and a degraded task. The background, in the degraded CPT test, had a pattern of snow, so that the stimulus was not as distinguishable, while in the ungraded part there was no pattern of snow. The results showed that as children age, their performance on the CPT improved, especially from ages 6 to 12. Also, on the degraded CPT test, boys performed better than the girls on measures of sensitivity and the hit rate. The authors conclude that during ages 6 to 12, cognitive inhibition is developing, and gender of the subjects should be taken into consideration when examining the performance on the degraded CPT test.

Greenberg and Waldman (1993) examined the impact of age on vigilance and sustained attention using the T.O.V.A. (Test of Variables of Attention). Seven hundred and seventy-five children, 6 to 16 years old, participated in the study. Each child was administered the T.O.V.A. This test presents a large white rectangle with a smaller black square either with the square in the upper portion of the rectangle (target stimulus) or the square in the lower portion of the rectangle. The subjects were instructed to press a response button as fast as possible as soon as the target stimulus was displayed. The task lasts for 22 minutes. In the first 11 minutes the target is infrequently presented while in the second 11 minutes the target is frequently presented. The measures of performance are errors of omission, errors of commission, response latency for correct decisions, and variability of response latencies for correct decisions. The T.O.V.A. requires some spatial discrimination, such as up and down, but does not require left-right discrimination. Also the T.O.V.A. has minimal demand of language. The results showed that standard deviation reaction time and the number of commission and omission errors decreased curvilinearly with age. The standard deviation reaction time measures the consistency of attention. The authors concluded that impulse control and attention improve with age and can be measured by the T.O.V.A.

In addition to age and gender, several studies have examined the effects of time of day on memory and cognitive performance of adults and children. Petros, Beckwith, and Anderson (1990) examined the impact of time of day of testing and morningness-eveningness on prose recall in adults. Participants were selected for the study if their score on the morningness/eveningness scale (Horne & Ostberg, 1976) determined that they were a "morning" type or "evening" type. Morning and evening type subjects were tested at either 9:00am, 2:00pm, or 8:00pm. Subjects were asked to listen to and immediately recall 5 short passages (200-220 words). The result of the study indicated that prose recall decreased across time of day for morning types while recall slightly increased across time of day for evening types. Petros et al. (1990) concluded that the impact of time of day performance on prose recall is effected by the individual's perception of whether he or she is morning or an evening type of person.

Folkard, Monk, Bradbury, and Rosenthall (1977) studied the effect of time of day on immediate and delayed recall in children. The participants were 68 female and 62 male students who ranged in age from 12 years 5 months to 13 years 4 months. Participants listened to a tape-recorded story, 2000 words in length, at either 9:00am or 3:00pm. Memory for the passage was assessed by requiring subjects to answer 20 multiple-choice questions. One third of the subjects answered the questions immediately after listening to each passage, while one third answered the questions one week later at the same time of day in which they originally heard the passage, and one third of the participants answered the questions one week later at the opposite time of day from which they originally heard the passage. The results indicated that immediate recall was significantly higher at 9:00am than at 3:00pm, while the opposite occurred for delayed recall. Folkard et al. (1977) concluded that the individual's arousal level, which increases throughout the day, affects immediate and delayed recall.

Folkard (1980) reanalyzed the data from Folkard et al. (1977). First Folkard had undergraduate students rate the importance of each multiple-choice question to the main theme of the story. Then Folkard (1980) examined memory changes across time of day as a function of the importance of the information. Folkard (1980) found that immediate recall decreased across time of day only for the less important information.

Dunne, Roche, and Hartley (1990) examined the effects of time of day on performance on free recall of words, recognition, and continuous retrieval from natural semantic categories in 16 adults. Each adult was tested once at 8:00am and once at 7:00pm. The participants were administered a free recall task, a recognition task, and a continuous retrieval task during each testing session. In the free recall task, the participant was shown a list of twelve words with one word shown at a time. After all twelve words in a list were shown, the participant was asked to write as many words as he or she could remember. There were a total of six lists. The recognition task was administered immediately following the recall of the sixth list. The participant was given a booklet containing 18 words shown in the free recall list task, 18 unrelated distracters and 18 related distracters. The participant was told to mark whether or not each word was from the free recall list or not. In the continuous retrieval task, the participant was given eight minutes per trial to name as many items as possible from the selected category (four-legged animals, toys, or nonalcoholic beverages). On the free recall task, participants performed better at 8:00am than 7:00pm. There was no difference in performance on the recognition memory test between participants tested at 8:00am versus participants tested at 7:00pm. The participants tested at 7:00pm performed better than participants tested at 8:00am on the continuous retrieval task.

The studies reviewed above suggest that memory performance changes across time of day for both children and adults. Several studies have also documented that vigilance performance changes across time of day. Horne, Brass and Pettitt (1980) had 10 moderate to extreme morning-type individuals and 10 moderate to extreme evening-type individuals participate in their study. Whether the individual was a morning type or an evening type was determined by his or her score on the Horne and Ostberg questionnaire (1976). The participants were to identify and discard incorrect items that passed by the participant on a conveyer belt. The participants were tested 15 times over five consecutive days. The participants were tested at a different hour each time, from 8:00am to 10:00pm. The authors reported that performance on a production-line inspection task was better for morning type subjects in the morning, while performance of evening types improved across time of day. Blake (1967) had subjects complete an auditory vigilance task at 8:00a.m., 10:30a.m., 1:00p.m., 3:30p.m., and 9:00p.m. The number of correct detections increased across time of day from the morning (8:00a.m.) to the afternoon (3:30p.m.). Blake (1967) also reported a 16msec. decrease across time of day in performance a simple motor-response task.

Rana, Rishi, and Sinha (1996) studied the effects of time of day on vigilance performance in children. Thirty children ages 10 to 16 participated in the study. A Paper and Pencil cancellation test (PPCT) was administered to the children, which measures vigilance performance. The PPCT consists of 25 consecutive lines with groups of three, four, or five dots per line. The child is asked to mark a specific group of dots as quickly as possible. The PPCT was administered at 9am, 2pm, or 6pm. The results showed that performance was better for accuracy and speed in the morning than in the afternoon or evening. Also, more errors were committed in the afternoon than in the morning or evening.

The above research has documented circadian changes in a wide range of cognitive tasks. One area of cognitive function, not yet examined for susceptibility to circadian influence, is that of executive function. Executive function refers to cognitive flexibility, self-regulation, organizing space and time, discriminating inhibition of responding, preparing responses, and set maintenance (Reader, Harris, Schuerholz, & Denckla, 1994). One component of executive functions, cognitive flexibility, can be measured by the Wisconsin Card Sorting Test (WCST). In this test, the individual is presented with 128 cards. The cards differ in number, color, and form. The individual begins to sort the cards into piles based upon one of the categories of number, color, or form, and the examiner only responds with the feedback of correct or incorrect. After ten consecutive correct responses, the category changes without warning. The number of perseverative errors (a pattern of incorrect responses even after feedback about their errors) is often the best indicator of problems with cognitive flexibility.

Sustained attention is a second component of executive function. The Continuous Performance Tests (CPT) measures sustained attention. The CPT assesses sustained attention by having the individual respond to the target stimuli and not respond to the non-target stimuli over an extended period of time. The primary dependent variables are errors of omission and commission along with response latency and variability of response latency.

Another task that has been frequently used to measure executive function is the Rey-Osterrieth Complex Figure (ROCF) which consists of a complex figure that the individual copies. Then the individual is asked to draw it from memory immediately following the copying. In order for an individual to do well on the ROCF, the individual must have good organizational and planning skills.

The Controlled Oral Word Association Test (COWAT) also measures executive function. The child is given a letter or a category and is asked to produce as many words as possible that begin with the letters presented (F, A, or S) or are members of the categories presented (fruits, animals, or parts of the body) in one minute (Reader et al., 1994). Another measure of executive functioning is the Stroop Color-Word Association Test which consists of three tasks. In the first task participants are first given a sheet of paper with a number of color hues and asked to name the colors as quickly as possible. Second they are given a sheet with a number of words printed in black and white that name colors and they are required to name the words as quickly as possible. In the third task, the participants are given a page with a list of color names that appear in a color different from the one named by the word. The participants are required to name the color of the ink that each word is written in, keeping in mind that color of the ink and the word name are different. The difference in reading time between the third page (color names in incongruous ink) and the first page (color hues) is a measure of interference (Barkley & Grodzinsky, 1994).

The Tower of London (TOL) is another measure of executive function. The individual in the Tower Of London is given three wooden balls and a block of wood with three varying sizes of pegs in it. The individual is asked to copy the picture they are shown in a set number of moves. This task measures behavioral inhibition and spatial planning (Kempton et al., 1999).

Research has found deficits in executive functioning in children diagnosed with Attention Deficit/Hyperactivity Disorder (ADHD). There are several studies that have compared executive function performance in children with ADHD and controls. Loge, Staton, and Beatty (1990) tested twenty ADHD children and 20 controls between the ages of 6 and 12. The participants were administered the Wechsler Intelligence Scale for Children –Revised (WISC-R; Wechsler, 1974), Design Fluency, Verbal Fluency, Reading Comprehension Test (Woodcock & Johnson, 1977), California Verbal Learning Test, Brown-Peterson Short-Term Memory Test, Wisconsin Card Sorting Task (Heaton, 1981), and Gordon Diagnostic System (Gordon & Mettelman, 1987) which has three tasks: the Vigilance Task, Distractibility Task, and Delay Task. In the Vigilance Task, the participants are presented with a series of numbers in the center of a three-column display and asked to respond whenever a 9 followed a 1. The Distractibility Task is similar to the Vigilance Task, however, numbers appear in all three columns. The individual only responds when the 1 followed by the 9 appears in the center. The individual in the Delay Task pushes a button to earn "points". However, if the individual pushes the button too quickly, the individual has to wait to respond again and no points would be counted. No information as to the duration of the required wait is provided to the individual. On the WISC-R, the ADHD participants scored in the average range, but their scores were significantly lower than that of the controls. The ADHD participants scored significantly lower on Digit Span, Block Design, Information, Arithmetic, and Coding subtests of the WISC-R. The ADHD children correctly recalled fewer words and had more word intrusions than the control children on the Brown-Peterson Short-Term Memory Test. There was no difference between the two groups on the Gordon Diagnostic System Delay Task. On the Distractibility and Vigilance Tasks, the ADHD children made more errors of commission than the controls. Also, on the Distractibility Task, the ADHD children detected fewer targets than the control children did. There were no significant differences found between the ADHD group and the controls on the Wisconsin Card Sorting Test, California Verbal Learning Test, and correct responses on the fluency tests. However, on the Design and Letter Fluency Tests the ADHD children committed more rule violations than the control children did. Loge et al. concluded that there are very few deficiencies in the frontal lobe functioning of ADHD children. Loge et al. believe that the inability to sustain, control, and direct attention are the most important contributing factors to the poor performance on memory and achievement tasks in ADHD children.

However, other studies on executive function and ADHD children found different results. Pineda et al. (1998) tested 124 boys from 7 to 12 years old. Sixty-two of the boys were diagnosed with ADHD while 62 boys were placed in the control group. The WISC-R, Wisconsin Card Sorting Test, and a Verbal Fluency test were administered to the children. The control group performed significantly better than the ADHD group on all the tests, but group differences were largest on the Wisconsin Card Sorting Test. Pineda et al. concluded that children with ADHD have executive dysfunction, and the WCST is the most sensitive measure of executive functioning.

Lavoie and Charlebois (1994) had forty-eight 12-year-old boys participate in their study. There were 16 disruptive boys without attention problems, 16 disruptive boys with significant attention problems, and 16 controls. The Stroop Color-Word Test was administered to the boys. In this task participants are first given a sheet of paper with a number of color hues and asked to name the colors as quickly as possible. Second they are given a sheet with a number of words printed in black and white that name colors and they are required to name the words as quickly as possible. Third, the participants are given a page with a list of color names that appear in a color different from the one named by the word. The participants are required to name the color of the ink that each word is written in, keeping in mind that color of the ink and the word name are different. The difference in reading time between the third page (color names in incongruous ink) and the first page (color hues) is a measure of interference. Also, the child's mother and teacher filled out the Behar Preschool Behavior Questionnaire. This questionnaire assesses the child's behavior on three different scales: hostile-aggressive, poor attention span and restlessness, and anxious-fearful. The mother and teacher filled out this questionnaire at two different times. The first time was when the child was 11, and the second time was one year later. The disruptive group and the disruptive group with attention problems performed worse on the Stroop Color-Word Test than the control group. The boys with attention problems performed the worst out of the three groups on the color-word card. The disruptive boys without attention problems performed better than the boys with attention problems, but worse than the control group on the color-word card. The color-word card assesses the individual's ability to focus attention on a single dimension while ignoring the stimuli's other dimensions. Lavoie and Charlebois concluded that children with attention problems have difficulty in selecting and extricating one dimension of the stimulus.

Reader, Harris, Schuerholz, and Denckla, (1994) had forty-eight ADHD children from the ages of 6 to 13 participate in their study. The computerized Wisconsin Card Sorting Test, the Test of Variables of Attention (TOVA), the Rey-Osterrieth Complex Figure (ROCF), and two word fluency tests: semantic trials from the Clinical Evaluation of Language Fundamentals and letter trials from the COWAT were administered to the participants. All the test scores that assessed executive function were changed into z scores based on age. Below average performance was represented by a negative z score. Above-average performance was represented by a positive z score. The ADHD children completed fewer categories on the Wisconsin Card Sorting Test than the normative sample. Also, the ADHD children made more errors of omission on the TOVA than the normative sample. However, the ADHD children performed in the average range on the Word Fluency tests and the ROCF. The researchers concluded that ADHD children have increased risk for exhibiting executive dysfunction.

Doyle, Bierderman, Seidman, Weber, and Faraone (2000) had 123 ADHD children and 103 controls participated in the study. The boys' ages ranged from 6 to 17 years old. They were participants of a 4-year longitudinal study. The Vocabulary, Arithmetic, Digit Span, Block Design, and Coding subtests from the WISC-R/WAIS-R were administered. The California Verbal Learning Test or WRAML, Rey-Osterrieth Complex Figure, the Stroop Color-Word Test, the Wisconsin Card Sorting Test, the Scattered Letter Version of the Visual Cancellations Test, and an auditory CPT were also administered to the boys. The boys with ADHD performed worse than the controls on the omission subscale in the auditory CPT, on the Freedom from Distractibility subscale of the WISC-R/WAIS-R, on the Color, Word, and Color-Word subscales of the Stroop Test, on the WCST, the ROCF, and the Letter Cancellation Task. The authors concluded that ADHD children exhibited inconsistent discrepancies on tests of executive function and attention. The authors noted that poor performance on several neuropsychological tests were predictive of ADHD, however good performance on neuropsychological tests does not rule out an ADHD diagnosis.

Houghton et al. (1998) took into account many of the methodological errors of previous studies such as inadequate neuropsychological measures, small sample size, and the use of medication which may underestimate executive dysfunction. One hundred and twenty-two children between the ages of 6 and 13 years old participated in the study. Sixty-two of the children were placed in the ADHD combined type group, 32 children in the ADHD predominantly inattentive group, and 28 children were placed in the control group. The ADHD children did not have comorbid diagnoses. The children were administered the Stroop Color and Word test, the Tower of London, the Matching Familiar Figures Test, the Wisconsin Card Sorting Test, and the Trail Making Test. The ADHD children stopped taking medication for at least 15 hours prior to their participation. The control group performed significantly better than both the ADHD subtypes on all measures. The children in the ADHD combined type performed significantly poorer on the Stroop Color-Word test and the Wisconsin Card Sorting Test than the control group and the predominantly inattentive ADHD group. The predominantly inattentive ADHD group performed poorer on these tasks than the control group, however, the results were not significant. Houghton et al. (1998) concluded that executive dysfunction is distinctly found in ADHD since these children with ADHD did not have comorbid diagnoses.

The research reviewed above indicated that children with ADHD perform worse on tests of executive function than non-ADHD children. The specific tasks, which produce group differences, vary somewhat from study to study but a majority of the studies report executive function deficit in ADHD children.

To date, no research has been conducted on the performance of Native American children on executive function tasks. As mentioned by Dauphinais and King (1992), one has to be careful when psychologically assessing Native American children on measures that are not reliable and valid to Native Americans. Alternatively, it can be argued that identification of cognitive measures that Native Americans do and do not differ on, and the variables that moderate the magnitude of these differences would enhance our understanding about differences between Caucasians and Native Americans and the source of these differences.

A number of studies found that time of day influences cognitive performance in children. Perhaps the time of day when children are tested can affect their performance on tests of executive function. Also, the literature has shown that Native Americans perform worse on Verbal subtests than Performance subtests on the WISC. A high percentage of Native American children received a diagnosis of ADHD and other childhood disorders.

Purpose of Present Study

The purpose of this study was to examine the effects of time of day of testing on performance on tests of executive functioning in Caucasian and Native American children. Previous work with Caucasian children reported better performance in the morning than in the afternoon (Folkard et al., 1977). The present study examined whether this pattern of previously observed time of day effects differed for Caucasian and Native American children.

CHAPTER II

METHODOLOGY

Participants

Eighty-four children between the ages 7 and 13 years old from the Grand Forks area participated in this study. Thirty children were Native American while fifty-four children were Caucasian. The children were tested at either 8-10am or 3-5pm.

Measures

Morningness-Eveningness

The Horne-Ostberg Morningness-Eveningness Questionnaire (Horne & Ostberg, 1976) is an adult, self-report questionnaire and consists of 19 questions. The questionnaire that was administered to the children in the present study was a modified version of the Horne-Ostberg Morningness-Eveningness Questionnaire. It consisted of 16 questions that required the child to report the time of day when they preferred to do a number of activities. Twelve questions have the children choose one of the four responses in which indicates "definite evening type", "moderate evening type", "moderate morning type", and "definite morning type". The four remaining questions require the children to mark their answers on an hour scale. Responses to each question are summed to provide one total score that ranges from 13 to 73. Higher scores indicate that the individual's optimal time of day is in the morning and lower scores indicate optimal time of day is in the evening.

Wechsler Intelligence Scale for Children – III

Vocabulary

The Vocabulary subtest from the Wechsler Intelligence Scale for Children-III (WISC-III; Wechsler, 1991) was administered. This test consists of 30 words in which the examiner states the word and the participant provides a brief definition. Each response is given 0, 1, or 2 points depending on the accuracy of the response and testing continues until the participant produces four consecutive 0-point responses. This subtest assesses the child's verbal ability.

Digit Span

The Digit Span subtest from the WISC-III consists of Digits Forward and Digits Backward sections. For the Digit Forward section, subjects were presented with sequences of numbers and were required to repeat the number sequences in the exact order they are presented. The sequences ranged from two to nine digits long with two sequences at each length. Participants were tested until they failed both sequences of a particular length. The Digits Backward section requires subjects to repeat the number sequences in reverse order. Digit Span assesses attention and short-term memory.

Executive Function Measures

Verbal Fluency

The Controlled Oral Word Association Test (COWAT; Benton and Hamsher, 1978) consists of two parts, letter fluency and category fluency. In the letter fluency test, the subject is allowed 60 seconds to list as many items as possible that begin with a particular letter. The letters tested are "F", "A", and "S". In the category fluency test, the subject is allowed 60 seconds to name as many items as possible that would belong in a particular category. The categories are "fruits" and "animals". The number of words correctly produced to the letters and categories are the dependent variables in the Verbal Fluency test.

Tower of London

The Tower of London task (TOL; Krikorian, 1994) contains a block of wood with three wooden pegs of varying heights, three wooden balls of different colors (blue, red, and green) that can be placed on the pegs, and pictures of specific arrangements of the balls on the pegs. The balls are placed in the "start position". The subject is shown an arrangement of the balls and is asked to match the picture in a certain number of moves. The subjects can only move one ball at a time and cannot hold one ball in their hand while moving another ball. The subjects were allowed three trials on each of the twelve picture arrangements. Three points were awarded for correctly completing the arrangement on the first trial, two points for the second trial, one point for the third trial, and zero points for not correctly matching the arrangement. The examiner recorded the amount of time to complete the arrangement and the number of correct responses.

Wisconsin Card Sorting Task

The Wisconsin Card Sorting Task (WCST; Heaton, 1981) assesses executive function. It consists of 128 cards that have designs that differ in number, color, and form. The subject is given four stimulus cards and is asked to sort the deck of cards corresponding with the stimulus cards. After ten consecutive cards have been matched correctly, the category for sorting the cards is switched without warning.

The measures of performance on the WCST include the number of trials to completion, the number of errors, and the number of perseverative errors, and the number of nonperseverative errors.

Conner's Continuous Performance Test

The Conner's CPT consists of ten upper-case letters including the letter X, which is designated as the target stimulus. Three hundred and sixty letters are presented on a computer screen one at a time. The CPT is divided into 18 consecutive blocks with 20 trials in each block. The 18 blocks contain different time delays between the presentation of successive numbers (interstimulus interval, ISI). The ISI is either 1, 2, or 4 seconds. The participant is asked to press the spacebar every time a letter appears except when the letter is "X". The measures of performance include the number of errors of omission, the number of errors of commission, response time latency and the variability of the response time latency. Each of these scores is presented as a T-score with a mean of 50 and standard deviation of 10. Hence, a higher T-score indicates poorer performance.

Behavior Measure

The Child Behavior Checklist (Achenbach, 1991) assesses several domains of children's emotional and behavioral functioning. It consists of 112 items in which the parents report on a three-point scale their child's functioning. The items are arranged into nine subscales to assess syndromes labeled Social Problems, Attention Problems, Withdrawn, Anxious/Depressed, Aggressive Behavior, Thought Problems, Somatic Complaints, Delinquent Behavior, and Sex Problems.

Procedure

The participants were randomly assigned to be tested in the morning (8:00am –10:00am) or in the afternoon (3:00pm – 5:00pm). The children were individually tested in a private room. Participants first filled out a demographic sheet requesting their name, age, sex, and grade in school. They were given a consent form to be signed by the parent and an assent form to be signed by the child, if both are in agreement for the child to participate. The experiment was then explained to the subjects. The parent was required to complete the Child Behavior Checklist. The Vocabulary and Digit Span from the WISC-III were administered first to the child. Next the child took the Conner's CPT. After a short break following the Conner's CPT, the child was given the Wisconsin Card Sorting Test. Then, the child was given the Tower of London test. The final test that was administered to the child was the Verbal Fluency test.

CHAPTER III

RESULTS

Subject Characteristics

For certain participants there is data missing on a few of the dependent measures. The total number of participants varies in the analysis depending on which dependent variables are examined. The alpha level for significant differences is set at $p < .05$.

Table 1
Subject Characteristics as a Function of Group and Time of Day

	Caucasian		Native American	
	AM	PM	AM	PM
Mean Age	9.77	9.52	9.00	9.73
SD	(2.49)	(1.62)	(1.96)	(1.39)
N	26	27	15	15
Mean Grade	3.88	4.11	3.47	4.13
SD	(1.86)	(1.82)	(2.07)	(1.55)
N	26	27	15	15
Morningness-Eveningness				
Mean	47.81	44.83	44.14	43.08
SD	(7.81)	(7.39)	(9.75)	(6.25)
N	26	26	14	13
WISC Vocabulary				
Mean	27.63	30.15	21.53	27.67
SD	(9.45)	(9.93)	(8.08)	(9.93)
N	27	27	15	15
Digit Span Forwards				
Mean	9.00	9.37	9.15	10.23
SD	(2.15)	(1.84)	(2.41)	(1.74)
N	27	27	13	13
Digit Span Backwards				
Mean	4.44	4.89	3.77	5.23
SD	(2.15)	(1.67)	(1.79)	(1.79)
N	27	27	13	13

The means and standard deviations for age, grade, morningness-eveningness, vocabulary and digit span scores are presented in Table 1 as a function of Time of Day and Racial Group. A 2(Group) X 2 (Time of Day) Analysis of Variance (ANOVA) was conducted separately on age and grade. No significant main effects or interactions were found for the analysis of age or grade. A 2(Group) X 2 (Time of Day) ANOVA was conducted on the morningness-eveningness questionnaire. No significant main effects or interactions were found.

Wechsler Intelligence Scale for Children – III Subtests

Vocabulary

A 2(Group) X 2(Time of Day) ANOVA was conducted on WISC-III Vocabulary subtest. The vocabulary scores ranged from 0 to 60. Significant main effects were found for Group, $F(1, 84) = 3.954$, $p<.05$, and Time of Day, $F(1,84)=4.023$, $p<.05$, but no interaction was found. The significant main effect of Group indicated that Caucasian children ($\underline{M}=28.29$) scored higher than Native American children ($\underline{M}=24.60$). The significant main effect of Time of Day indicated that Vocabulary scores were lower in the morning ($\underline{M}=24.58$) than the afternoon ($\underline{M}=28.90$). In light of significant group differences on Vocabulary subtest, all analysis will be computed with and without vocabulary as an adjustment.

Digit Span

A 2(Group) X 2 (Time of Day) ANOVA was conducted separately on the Digit Span Forwards and Digit Span Backwards. No significant effects were found for the Digit Span Forwards. A significant main effect for Digit Span Backwards was found, $F(1,80)=4.487$, $p<.05$. This main effect indicated that the children tested in the morning (M=4.11) remembered fewer digit strings than the children in the afternoon (M=5.06). A 2(Group) X 2 (Time of Day) Analysis of Covariance (ANCOVA) was conducted on Digit Span Forwards and Backwards with Vocabulary as the covariate. A significant main effect for Group was found in Digit Span Forward, $F(1,80)=4.991$. Native American children (10.03) remembered more digit strings than Non-Native American children (9.02). No main significant effects or interactions were found for Digit Span Backwards.

Executive Function Measures

Verbal Fluency

The number of words produced to letters and categories was compiled separately for each participant and the scores were subjected to a 2(Group) X 2 (Time of Day) ANOVA separately for Letter Fluency and Category Fluency. A main effect of Group was found for both the Letter Fluency, $F(1, 84)=14.41, p<.05$, and Category Fluency, $F(1,84)=6\ 734, p<.05$. For both Letter (M=25.43 vs. M=17.13) and Category Fluency (M=23.59 vs. M=19.87) Caucasian Children scored significantly higher than Native American children (See Table 2). A 2(Group) X 2 (Time of Day) ANCOVA was conducted on the Letter Fluency and Category Fluency tests with Vocabulary being the covariate. A main effect for Group was found on Letter Fluency, $F(1, 84)=9.845, p<.05$. The main effect of Group indicated that Caucasian children (M=24.64) scored significantly higher than Native American children (M=18.55). However, no main effects or interactions were found for Category Fluency.

Tower of London

On the Tower of London, scores range from 0 to 36. The higher the total score, the better the individual performed. A 2(Group) X 2 (Time of Day) ANOVA was conducted on the Tower of London. A main effect for Group was found, $F(1,82)=5.692, p<.05$. This main effect showed that Caucasian children (M=29.75) scored higher than Native American children (M=27.70) (See Table 2). An ANCOVA with Vocabulary as the covariate was conducted on the Tower of London. No main effects or interactions were found in the ANCOVA.

Table 2
Executive Function Measures as a Function of Group and Time of Day

	Caucasian		Native American	
	AM	PM	AM	PM
Letter Fluency				
Mean	26.41	24.44	15.47	18.80
SD	(12.08)	(8.10)	(7.68)	(8.60)
N	27	27	15	15
Category Fluency				
Mean	23.19	24.00	18.47	21.27
SD	(7.62)	(5.18)	(6.49)	(5.24)
N	27	27	15	15
Tower of London				
Mean	29.85	29.65	27.73	27.67
SD	(2.69)	(4.59)	(2.96)	(4.35)
N	26	26	15	15

Wisconsin Card Sorting Task

The variables of interest from the Wisconsin Card Sorting Task (WCST) are the number of trials administered to the children, the number of correct trials, the total number of errors, perseverative responses, perseverative errors, the total number of categories completed, the number of trials to complete the first category, and the failure to maintain set. The number of trials administered, the number of correct trials, and the number of categories completed are presented as raw scores. However, all the remaining measures were converted to a T score based upon the child's age. Average performance has a T score of 50. Poor performance on these scales is represented by a T score lower than 50. Each of these variables were subjected separately to 2(Group) X 2 (Time of Day) ANOVA. A main effect for Group was found in the Number of Trials, $F(1,81)=17.905$, $p<.05$, the Number of Errors score, $F(1,80)=26.025$, $p<.05$, the Number of Perseverative Responses score, $F(1,80)=44.272$, $p<.05$, the Number of Perseverative Errors score, $F(1, 79)=37.715$, $p<.05$, and Number of Categories completed, $F(1, 80)=12.445$, $p<.05$. The main effect for Number of Trials indicated that Caucasian children (M=98.17) took fewer trials than Native American (M=117) to complete this task. The main effect for Number of Errors showed that Caucasian children (mean T score =57.62) made fewer errors than Native American children (mean T score =46.53). Native American children (mean T score =45.57) made more Perseverative Responses than Caucasian children (mean T score =59.67). Also, Native American children (mean T score =45.27) made more Perseverative Errors than Caucasian children (mean T score =58.67). Also, Native American children (M=4.40) completed fewer categories than Caucasian children (M=5.53).

A main effect for Time of Day was found in the Total Correct, $F(1, 81)=5.278$, $p<.05$, Number of Errors, $F(1,80)=5.977$, $p<.05$, the Number of Perseverative Responses, $F(1,80)=6.143$, $p<.05$, and the Number of Perseverative Errors, $F(1,79)=5.897$, $p<.05$. The main effect for the total number of correct trials indicated that children tested in the morning (M=70.61) had fewer correct trials than children tested in the afternoon (M=76.82). The children tested in the morning (mean T score =49.42) made more errors than the children tested in the afternoon (mean T score =54.73). The children tested in the morning (mean T score =49.99) had more Perseverative Responses than the children tested in the afternoon (mean T score =55.24). Also, the children tested in the morning (mean T score =49.32) had more Perseverative Errors than the children tested in the afternoon (mean T score =54.62). No significant interactions were found (See Table 3).

A 2(Group) X 2 (Time of Day) ANCOVA was conducted on each of the variables from the WCST with Vocabulary as the covariate. A main effect for Group was found in the Number of Trials, $F(1,81)=12.575$, $p<.05$, the Number of Errors score, $F(1,80)=20.321$, $p<.05$, the Number of Perseverative Responses score, $F(1,80)=36.880$, $p<.05$, the Number of Perseverative Errors score, $F(1,79)=31.052$, $p<.05$, and the Number of Categories $F(1,80)=8.641$. The main effect for Number of Trials indicated that Caucasian children (M=99.33) took fewer trials than Native American (M=115.00) to complete this task. The main effect for Number of Errors showed that Caucasian children (mean T score =57.16) made fewer errors than Native American children (mean T score =47.31). Native American children made more Perseverative Responses (mean T score =46.24 vs. mean T score =59.28) and Perseverative Errors (mean T score =45.95 vs. mean T score =58.26) than Caucasian children. Also, Native American children (M=4.51) completed fewer categories than Caucasian children (M=5.47). In summary, when controlling for Vocabulary, Caucasian children performed better on the number of trials, number of errors, number of perseverative responses, number of perseverative errors, and the number of categories completed. That is, there was no change in the results when vocabulary was controlled.

Table 3
Means and Standard Deviations of the Wisconsin Card Sorting Task

	Caucasian		Native American	
	AM	PM	AM	PM
Total Number of Trials				
Mean	98.75	97.59	120.73	113.27
SD	(21.04)	(20.31)	(13.67)	(19.35)
N	24	27	15	15
Number of Correct Trials				
Mean	71.42	77.37	69.80	76.27
SD	(9.94)	(11.11)	(15.38)	(11.40)
N	24	27	15	15
Total Number of Errors T Score				
Mean	55.30	59.93	43.53	49.53
SD	(10.38)	(8.37)	(9.55)	(9.42)
N	23	27	15	15
Perseverative Responses T Score				
Mean	58.78	60.56	41.20	49.93
SD	(9.93)	(8.32)	(10.43)	(8.00)
N	23	27	15	15
Perseverative Errors T Score				
Mean	57.30	60.04	41.33	49.20
SD	(9.29)	(9.19)	(10.38)	(8.95)
N	23	26	15	15
Number of Categories				
Mean	5.29	5.77	4.27	4.53
SD	(1.43)	(0.65)	(1.71)	(1.85)
N	24	26	15	15
Number to Complete First Category				
Mean	18.13	15.58	21.93	15.07
SD	(24.15)	(8.75)	(16.64)	(8.90)
N	24	26	14	14
Failure to Maintain Set				
Mean	0.96	1.35	0.73	1.20
SD	(1.52)	(1.26)	(0.96)	(1.32)
N	24	26	15	15

The results of the ANCOVA also revealed a main effect for Time of Day in the Total Correct, $F(1,81)=5.300$, $p<.05$, Number of Errors T score, $F(1,80)=4.042$,

$p<.05$, the Number of Perseverative Responses T score, $F(1,80)=4.338$, $p<.05$, and the Number of Perseverative Errors score, $F(1,79)=4.138$, $p<.05$. The main effect for the total number of correct trials indicated that children tested in the morning (M=70.50) had fewer correct trials than children tested in the afternoon (M=76.87). The morning children (M T score =50.97) made more errors than the evening children (mean T score =54.41). Also, the children tested in the morning had more Perseverative Responses (mean T score =50.55 vs. mean T score =54.97) and more Perseverative Errors (mean T score =49.89 vs. mean T score =54.32) than the children tested in the afternoon. When vocabulary was used as the covariate, the results for Time of Day did not change. The children tested in the afternoon performed better than the children tested in the morning on total correct, number of errors, number of perseverative responses, and the number of perseverative errors. No significant interactions were found.

Conner's Continuous Performance Task

A 2(Group) X 2 (Time of Day) ANOVA was conducted separately on each the T scores of the scales from the Connor's Continuous Performance Task (CPT). A main effect for Group was found in Errors of Omission, $F(1, 81)=8.322$, $p<.05$. The Caucasian children (M=44.76) made fewer errors of omission than the Native American children (M=51.73). A main effect for Time of Day was found in Hit Response Time, $F(1,81)=5.647$, $p<.05$, Standard Error of Hit Response Time, $F(1, 81)=12.401$, $p<.05$, Variability of Response, $F(1,81)=5.091$, $p<.05$, and Hit Response Rate Block Change, $F(1,81)=4.100$, $p<.05$. The main effect for Hit Response Time indicated that children tested in the morning (M=48.80) responded slower than the children in the afternoon (M=43.62). The main effect for Standard Error of Hit Response Time showed that the children in the morning (M=53.51) had higher standard error than the children tested in the afternoon (M=46.70). The children tested in the morning (M=51.69) had more response variability than the children tested in the afternoon (M=46.99). The main effect for Hit Response Rate Block Change indicated that, as the task progressed, the morning children (M=52.38) responded slower than the children tested in the afternoon (M=48.43). No interactions were found (See Table 4).

A 2(Group) X 2 (Time of Day) ANCOVA using Vocabulary as the covariate found a main effect for Group on Errors of Omission, $F(1,81)=6.827$, $p<.05$. The Caucasian children (M=44.94) made fewer errors of omission than the Native American children (M=51.43). The results for the ANOVA and the ANCOVA for Group were the same. Also, main effects were found for Time of Day on Standard Error of Hit Rate, $F(1,81)=10.241$, $p<.05$, and Variability of Response, $F(1,81)=4.377$, $p<.05$. The main effect for Standard Error of Hit Response Time showed that the children in the morning (M=53.26) higher standard error than the children tested in the afternoon (M=46.86). The morning children (M=51.59) had more response variability than the afternoon children (M=47.06). When Vocabulary was used as the covariate, the pattern of results changed. There were no significant main effects for Hit Response Time or Hit Response Rate Block Change which were found in the ANOVA. There were significant results for Standard Error of Hit Response and Variability of Response with afternoon children performing better than the children tested in the morning. No interactions were found.

Table 4
T Score Means of CPT Measures as a Function of Group by Time of Day

	Caucasian		Native American	
	n=26	n=25	n=15	n=15
	AM	PM	AM	PM
Errors of Omission				
Mean	44.43	45.09	55.59	47.87
SD	(8.63)	(8.70)	(16.99)	(7.46)
Errors of Commission				
Mean	52.00	47.62	51.99	52.36
SD	(10.02)	(10.22)	(6.38)	(10.85)
Hit Rate				
Mean	47.00	42.27	50.60	44.96
SD	(9.46)	(9.72)	(7.94)	(10.46)
SE of Hit Rate				
Mean	51.77	46.14	55.26	47.25
SD	(7.51)	(7.94)	(8.69)	(10.24)
Variability				
Mean	48.66	47.09	54.72	46.89
SD	(5.80)	(10.31)	(9.60)	(10.82)
D Prime				
Mean	50.55	52.01	53.39	51.18
SD	(6.31)	(9.26)	(6.42)	(9.24)
Response Style				
Mean	47.14	48.05	50.06	48.73
SD	(7.19)	(6.93)	(4.49)	(9.02)
Perservative Responses				
Mean	51.91	47.54	52.43	48.32
SD	(28.21)	(12.16)	(5.56)	(6.64)
Hit Rate BC				
Mean	51.60	46.63	53.16	50.24
SD	(7.01)	(7.77)	(9.10)	(11.01)

Behavior Measure

A standard T score was computed for each of the scales of the Child Behavior Checklist (CBCL). A 2(Group) X 2 (Time of Day) ANOVA was conducted separately on each of the Child Behavior Checklist scales. No significant effects were observed in any of these analyses (See Table 5).

Table 5

Means and Standard Deviations of the Child Behavior Checklist

	Caucasian		Native American	
	n=15	n=17	n=14	n=12
	AM	PM	AM	PM
Withdrawn				
M	52.60	53.94	51.29	53.42
SD	(4.61)	(6.53)	(2.27)	(5.68)
Somatic Complaints				
M	55.33	54.29	54.00	54.75
SD	(6.08)	(5.45)	(6.67)	(6.89)
Anxious/Depressed				
M	53.20	53.18	54.00	53.42
SD	(5.37)	(5.02)	(5.39)	(4.46)
Social Problems				
M	53.13	52.71	53.29	51.25
SD	(8.53)	(4.54)	(5.41)	(3.11)
Thought Problems				
M	52.93	52.12	55.07	53.92
SD	(5.47)	(4.20)	(6.86)	(6.39)
Attention Problems				
M	54.33	51.88	53.57	52.00
SD	(7.05)	(3.10)	(6.86)	(3.79)
Delinquent Behavior				
M	51.60	52.29	52.29	52.75
SD	(3.50)	(4.04)	(4.41)	(5.05)
Aggressive Behavior				
M	53.00	52.06	53.29	52.25
SD	(5.33)	(3.42)	(5.70)	(4.35)
Internal Behavior				
M	47.73	47.71	48.64	49.67
SD	(10.66)	(11.17)	(9.50)	(9.53)
External Behavior				
M	46.13	45.82	48.21	45.92
SD	(10.18)	(8.16)	(10.15)	(8.90)

CHAPTER IV

DISCUSSION

The results of the present study revealed several measures of executive function in which Caucasians performed better than Native Americans, even after group differences in verbal ability were statistically adjusted. In addition, performance on several measures of executive function varied across time of day. However, differences in performance between Native Americans and Caucasians did not vary as a function of time of day on any of the measures observed.

The results showed that there was time of day effects on several of the executive function measures. The children tested in the afternoon performed better than the children tested in the morning on the Wisconsin Card Sorting Test. Children tested in the afternoon had more correct trials, less number of errors, less perseverative responses, and less perseverative errors than morning children. These results indicate that the children tested in the afternoon had more mental flexibility than children tested in the morning. When vocabulary was used as a covariate, the results did not change. This indicates that the results are not due to confounds in overall intellectual ability.

Also, the children tested in the afternoon performed better than the children tested in the morning on the Conner's Continuous Performance Test. The results showed that the children tested in the morning had a slower hit response time than afternoon children. The children tested in the morning had greater inconsistency in their response speed than children tested in the afternoon, and had more response variability. Also, the children tested in the morning had a higher hit reaction time by block change than afternoon children, indicating that afternoon children quickened as the test progressed. However, when an Analysis of Covariance was completed with vocabulary as the covariate, a significant main effect was found only for standard error of hit reaction time and variability of response. This indicates that children tested in the morning have greater inconsistency in their response speed. The superior performance of children on tests of executive function in the afternoon was also found by Remmick et al. (2003).

However, these findings conflict with Rana, Rishi and Sinha (1996) results. Rana et al. studied the effects of time of day on vigilance performance in children using the Paper and Pencil Cancellation Test (PPCT). They found that performance of accuracy and speed was better in the morning and that more errors were made in the afternoon. Folkard et al (1977) found that immediate recall was significantly better in morning, but delayed recall significantly better in the afternoon for children.

The results indicated that there were group differences on the executive function measures. Caucasian children listed more words on the letter and category fluency tests than the Native American children. Past research has found that Non-Native American children perform better on the Verbal Scales for the WISC-R (Mishra, 1982; McCullough et al, 1985; Beiser & Gotowiec, 2000). On the Tower of London, Caucasian children performed better than the Native American children. The Caucasian children performed better on the Wisconsin Card Sorting Test. Caucasian children took fewer trials to complete the test. Also, the Caucasian children made fewer errors, perseverative errors, and perseverative responses. These results indicate that Caucasian children show more mental flexibility than Native American children. On the Conner's Continuous Performance Test, Caucasian children made fewer Errors of Omission. This indicates that Native American children were less attentive than Caucasian children on the CPT.

One major limitation of this study was that the family social economic status was not obtained. Perhaps, the Native American children were from a lower SES than Caucasian children, thus accounting for the group differences observed. One the most prominent differences between children from different social classes is different performance on intellectual tests with middle class having higher IQ scores than lower class. Vocabulary ability is highly correlated with overall IQ score. Accordingly, the use of analysis of covariance with vocabulary as the covariate, and the continued observation of group differences argues against this interpretation. Future work comparing Native Americans and Caucasians needs to account for SES differences. A second limitation of the present study was the absence of any measure of assimilation or acculturation of the Native American children. Perhaps, the differences were due to lack of acculturation of the Native American children. Mc Shane and Plas (1982) reported a different pattern of results on IQ performance when Ojibwa Native American children were classified as acculturated or traditional. However, most of the Native American parents were enrolled in college suggesting that our sample was reasonably homogeneous. However, in the absence of any direct measures of acculturation, the source of Native American deficits on these tasks remain unclear. Finally, previous work comparing Caucasian and Native American participants were clinically referred, thus confounding racial group membership with psychopathology. However, absence of group differences on the Child Behavior Checklist (Achenbach, 1991), in the present results, argues that psychopathology was similar across groups thus removing that confound for consideration.

Future research on executive functioning in Native American children needs to examine the SES of the children tested and their performance. Also, future research needs to include a measure of acculturation or assimilation to determine its impact on performance. Finally, future research should measure chronic sleep habits of the children tested, since lack of sleep may affect the child's performance on the executive tasks.

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