SIMULTANEOUS AND SEQUENTIAL PROCESSING, READING,
AND NEUROLOGICAL MATURATION OF NATIVE INDIAN
(TSIMSHIAN) CHILDREN.

by

DAVID GEORGE WILLIAMS

B.A., The University of British Columbia, 1965
M.A., The University of British Columbia, 1969

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF EDUCATION

in
THE FACULTY OF GRADUATE STUDIES
EDUCATIONAL PSYCHOLOGY AND SPECIAL EDUCATION

We accept this thesis as conforming
to the required standard:

THE UNIVERSITY OF BRITISH COLUMBIA

October 1986

© David George Williams, 1986
In presenting this thesis in partial fulfillment of the requirements for an advanced degree at the University of British Columbia, I agree that the Library shall make it freely available for reference and study. I further agree that permission for extensive copying of this thesis for scholarly purposes may be granted by the Head of my Department or by his or her representatives. It is understood that copying or publication of this thesis for financial gain shall not be allowed without my written permission.

Department of: EDUCATIONAL PSYCHOLOGY and SPECIAL EDUCATION

The University of British Columbia
1956 Main Mall
Vancouver, Canada
V6T 1Y3

Date: October 6, 1986
This study was designed to investigate the relationship between the developmental trends for Simultaneous and Sequential Information Processing and the developmental trends for Reading and Neurological Maturation, and if these trends are influenced by cultural/experiential background.

Differences in Kaufman Assessment Battery for Children: Mental Processing trends (for Simultaneous and Sequential Processing) between North Coast B.C. Native Indian (Tsimshian) children and Non-Native children, as well as differences in the developmental trends for reading decoding and comprehension (B.C. QUIET: Word Identification and Passage Comprehension subtests, and K-ABC: Reading Understanding subtest), and neurological maturation (Grip Strength Test) were examined with a sample of 225 children ages 8-12. Since cultural/experiential background was proposed as a primary influence on the dependent variables, two samples of Native Indian children were used: one from isolated north coast B.C. villages and the other from the north coast city of Prince Rupert. The Non-Native sample also came from Prince Rupert.

Canonical analysis revealed significant relationships between Ethnicity and Simultaneous and Sequential Processing, the Simultaneous and Processing Subtests, Reading, and Neurological Maturation variables. Differences between the two Native groups were more significant than differences between the Non-Native and either Native group.
There was no observable "Native Indian pattern" of Simultaneous and Sequential Processing. What was observable was a different maturational rate for the Village-Native group on Information Processing, Reading, and Neurological Maturation. These differences are interpreted as differences in maturational rate rather than permanent deficits in function.

An anticipated lag in the development of sequential processing skills by the Native Indian groups was not evident. Both modes of processing were available to each group at every age level. The Non-Native group came closest to displaying a lag in sequential processing skills.

It was concluded that Simultaneous and Sequential Information Processing, Reading, and Neurological Maturation displayed similar developmental trends which were primarily determined by Age and cultural/experiential background.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABSTRACT</td>
<td>11</td>
</tr>
<tr>
<td>TABLE OF CONTENTS</td>
<td>iv</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>viii</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>ix</td>
</tr>
<tr>
<td>LIST OF APPENDICES</td>
<td>x</td>
</tr>
<tr>
<td>Acknowledgement</td>
<td>xii</td>
</tr>
</tbody>
</table>

## CHAPTER I INTRODUCTION

The Purpose of the Study..................................................................................... 1
Statement of the Problem.................................................................................... 4
Importance of the Study...................................................................................... 4
  Educational Context......................................................................................... 4
  Experiential Context....................................................................................... 5
  Theoretical Context......................................................................................... 6
Description of Terms.......................................................................................... 8
  Ethnicity........................................................................................................... 8
  Simultaneous and Sequential Processing..................................................... 8
  Simultaneous Processing.................................................................................. 8
  Sequential Processing...................................................................................... 8
  Neurological Maturation................................................................................... 9
Research Hypotheses.......................................................................................... 9
Statistical Hypotheses....................................................................................... 13
Method of Study................................................................................................ 15
Limitations of the Study..................................................................................... 16

## CHAPTER II REVIEW OF THE LITERATURE

Native Indian Culture and School Achievement............................................. 18
Economic Disadvantage and Learning............................................................. 22
Native Indian Culture and Cognitive Style.................................................... 27
Traditional Lifestyle and Learning Style....................................................... 32
Culturally Determined Learning Strengths of Native Indian Children............ 37
The Simultaneous and Sequential Processing Model of Cognitive Abilities ................................................. 41
Cultural Preferences for Information Processing ...................................................................................... 45
Linguistic Functioning ............................................................................................................................ 47
Simultaneous and Sequential Processing and Reading ........................................................................... 51
The Information Processing Model and the K-ABC ............................................................................. 60
The Kaufman Assessment Battery for Children: K-ABC ................................................................... 65
  Theoretical Support for the K-ABC ........................................................................................................ 65
  Validity of the K-ABC .......................................................................................................................... 70
  The K-ABC and Minority Group Differences ...................................................................................... 76
  The K-ABC and Reading ....................................................................................................................... 77
  The K-ABC and Educational Intervention .......................................................................................... 79
The British Columbia Quick Individual Educational Test: B.C. QUIET .............................................. 83
The Grip Strength Test ............................................................................................................................ 87
  Grip Strength as a Measure of Neurological Maturation ................................................................. 90

<table>
<thead>
<tr>
<th>CHAPTER III  METHOD OF STUDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population ................................................................. 97</td>
</tr>
<tr>
<td>Sampling ....................................................................... 97</td>
</tr>
<tr>
<td>Description of Subjects in the Sample .......................... 98</td>
</tr>
<tr>
<td>Method of Obtaining the Sample ................................... 99</td>
</tr>
<tr>
<td>Limitations of the Sample ........................................... 101</td>
</tr>
<tr>
<td>Instrumentation ............................................................ 103</td>
</tr>
<tr>
<td>Dependent Variables ..................................................... 104</td>
</tr>
<tr>
<td>Simultaneous Processing .............................................. 104</td>
</tr>
<tr>
<td>Sequential Processing .................................................. 104</td>
</tr>
<tr>
<td>Description of the K-ABC Mental Processing Scale Subtests .......................... 105</td>
</tr>
<tr>
<td>Validity-Reliability of the K-ABC ................................ 105</td>
</tr>
<tr>
<td>Word Identification ................................................................ 106</td>
</tr>
<tr>
<td>Passage Comprehension ............................................... 106</td>
</tr>
<tr>
<td>Validity-Reliability of the B.C. QUIET .......................... 107</td>
</tr>
<tr>
<td>Reading Understanding ................................................ 107</td>
</tr>
<tr>
<td>Grip Strength ............................................................... 107</td>
</tr>
<tr>
<td>Validity-Reliability of the Grip Strength Test ................ 108</td>
</tr>
</tbody>
</table>
Independent Variables ................................................................. 109
  Age ....................................................................................... 109
  Sex ....................................................................................... 109
  Ethnicity ............................................................................. 110
  Administration ..................................................................... 110
  Scoring ................................................................................ 112
  Transformation of Scores ...................................................... 112
  Data Collection and Processing ........................................... 112
  Research Design .................................................................. 113
  Statistical Hypotheses ......................................................... 114
  Method of Analysis ............................................................... 114
    Mean Scores and Standard Deviations .................................. 114
    Canonical Analysis (CA) ..................................................... 115
    Analysis of Variance (ANOVA) ........................................... 119

CHAPTER IV RESULTS OF THE STUDY

Summary of Descriptive Data ..................................................... 121
  Research Hypothesis 1: Canonical Correlation of Ethnicity, Age, and
    Sex with Simultaneous and Sequential Processing .................. 126
  Research Hypothesis 2: Canonical Correlation of Ethnicity, Age, and
    Sex with the Simultaneous and Sequential Processing Subtests .... 135
  Research Hypothesis 3: Canonical Correlation of Ethnicity, Age, and
    Sex with the Reading Subtests ........................................... 146
  Research Hypothesis 4: Canonical Correlation of Ethnicity, Age, and
    Sex with the Neurological Maturation Subtests ..................... 158
  Summary of the Research Hypotheses .................................... 167

CHAPTER V DISCUSSION, SUMMARY, CONCLUSIONS, AND
RECOMMENDATIONS.

Purpose of the Study ................................................................ 169
  Discussion ............................................................................. 170
    Research Hypotheses ......................................................... 170
      Research Hypothesis 1 ....................................................... 170
      Research Hypothesis 2 ....................................................... 171
LIST OF TABLES

Table 1: Means and Standard Deviations for Village-Native Children at Each Age Level................................................................. 123
Table 2: Means and Standard Deviations for Non-Native Children at Each Age Level................................................................. 124
Table 3: Means and Standard Deviations for City-Native Children at Each Age Level................................................................. 125
Table 4: Canonical Analysis: Test for Multicollinearity of Variables... 128
Table 5: Bartlett’s Test for Significance of Eigenvalues......................... 129
Table 6: Summary Statistics for Canonical Correlation of Ethnicity, Age, and Sex with Simultaneous and Sequential Processing..... 130
Table 7: ANOVA for Canonical Variate Scores, Y(1), for the Factor Ethnicity...................................................................................... 133
Table 8: Scheffe Post-Hoc Pairwise Comparison of Group Means on Y(1) for Three Ethnicity Groups...................................................... 133
Table 9: Canonical Analysis: Test for Multicollinearity of Variables... 136
Table 10: Bartlett’s Test for Significance of Eigenvalues......................... 139
Table 11: Summary Statistics for Canonical Correlation of Ethnicity, Age, and Sex with the Simultaneous and Sequential Processing Subtests................................................................. 140
Table 12: ANOVA for Canonical Variate Scores, Y(1), for Three Levels of Ethnicity and Five Levels of Age.................................................. 143
Table 13: Canonical Analysis: Test for Multicollinearity of Variables... 149
Table 14: Bartlett’s Test for Significance of Eigenvalues......................... 150
Table 15: Summary Statistics for Canonical Correlation of Ethnicity, Age, and Sex with the Reading Subtests.................................................. 151
Table 16: ANOVA for Canonical Variate Scores, Y(1), for Three Levels of Ethnicity and Five Levels of Age.................................................. 154
Table 17: Canonical Analysis: Test for Multicollinearity of Variables... 160
Table 18: Bartlett’s Test for Significance of Eigenvalues......................... 161
Table 19: Summary Statistics of Canonical Correlation of Ethnicity, Age, and Sex with Neurological Maturation.............................. 162
Table 20: ANOVA for Canonical Variate Scores, Y(1), for Three Levels of Ethnicity and Five Levels of Age.................................................. 164
LIST OF FIGURES

Figure 1: Research Design with Three Levels of Ethnicity and Five Levels of Age.................................................................120
Figure 2: Linearity of Relationship Between the First Canonical Variates.................................................................................127
Figure 3: Linearity of Relationship Between the First Canonical Variates.................................................................................137
Figure 4: Linearity of Relationship Between the Second Canonical Variates..............................................................................138
Figure 5: Cell Means on Y(1) for Three Levels of Ethnicity and Five Levels of Age.................................................................144
Figure 6: Linearity of Relationship Between the First Canonical Variates.................................................................................147
Figure 7: Linearity of Relationship Between the Second Canonical Variates..............................................................................148
Figure 9: Linearity of Relationship Between the First Canonical Variates.................................................................................149
Figure 10: Cell Means of ANOVA of Canonical Variate T-Scores on Y(1), for Three Levels of Ethnicity and Five Levels of Age...165
LIST OF APPENDICIES

Map of Prince Rupert Region ................................................................. 235
General Information Letter ................................................................. 236
Teacher Information Letter ............................................................... 237
Parental Information Letter ................................................................. 238
Parental Consent Form ........................................................................ 239
Principal's Supporting Letter ................................................................. 240
Graphs of Cell Means ......................................................................... 241

Figure 11: Cell Means for Simultaneous Processing for Village-
Native, Non-Native, and City-Native Children .................................. 241
Figure 12: Cell Means for Sequential Processing for Village-
Native, Non-Native, and City-Native Children ................................ 241
Figure 13: Cell Means for Simultaneous Processing Subtests for
Village-Native Children .................................................................. 242
Figure 14: Cell Means for Simultaneous Processing Subtests for
Non-Native Children ...................................................................... 242
Figure 15: Cell Means for Simultaneous Processing Subtests for
City-Native Children ..................................................................... 243
Figure 16: Cell Means for Gestalt Closure Subtest for Village-
Native, Non-Native, and City-Native Children .............................. 243
Figure 17: Cell Means for Triangles Subtest for Village-Native,
Non-Native, and City-Native Children ......................................... 244
Figure 18: Cell Means for Matrix Analogies Subtest for Village-
Native, Non-Native, and City-Native Children .............................. 244
Figure 19: Cell Means for Photo Series Subtest for Village-
Native, Non-Native, and City-Native Children .............................. 245
Figure 20: Cell Means for Spatial Memory Subtest for Village-
Native, Non-Native, and City-Native Children .............................. 245
Figure 21: Cell Means for Sequential Processing Subtests for
Village-Native Children .................................................................. 246
Figure 22: Cell Means for Sequential Processing Subtests for
Non-Native Children ...................................................................... 246
Figure 23: Cell Means for Sequential Processing Subtests for
City-Native Children ..................................................................... 247
Figure 24: Cell Means for Hand Movements Subtest for Village-
Native, Non-Native, and City-Native Children .............................. 247
Figure 25: Cell Means for Number Recall Subtest for Village-Native, Non-Native, and City-Native Children .......................................................... 248
Figure 26: Cell Means for Word Order Subtest for Village-Native, Non-Native, and City-Native Children .......................................................... 248
Figure 27: Cell Means of Simultaneous and Sequential Processing for Village-Native Children .......................................................... 249
Figure 28: Cell Means of Simultaneous and Sequential Processing for Non-Native Children .......................................................... 249
Figure 29: Cell Means of Simultaneous and Sequential Processing for City-Native Children .......................................................... 250
Figure 30: Cell Means of Word Identification Subtest for Village-Native, Non-Native, and City-Native Children .......................................................... 250
Figure 31: Cell Means of Passage Comprehension Subtest for Village-Native, Non-Native, and City-Native Children .......................................................... 251
Figure 32: Cell Means of Reading Understanding Subtest for Village-Native, Non-Native, and City-Native Children .......................................................... 251
Figure 33: Cell Means of Reading Subtests for Village-Native Children ........................................................................................................................................ 252
Figure 34: Cell Means of Reading Subtests for Non-Native Children ........................................................................................................................................ 252
Figure 35: Cell Means of Reading Subtests for City-Native Children ........................................................................................................................................ 253
Figure 36: Cell Means of Grip Strength Dominant Hand Subtest for Village-Native, Non-Native, and City-Native Children .......................................................... 253
Figure 37: Cell Means of Grip Strength Other Hand Subtest for Village-Native, Non-Native, and City-Native Children .......................................................... 254
Acknowledgements

Special thanks are due to the following:

Dr. Arthur More, my thesis advisor who has offered considerable encouragement and support throughout this study.

Dr. Walter Boldt, for cheerful and expert advice on the statistical and methodological aspects of the study.

Dr. O.A. Oldridge, for his encouragement and optimism.

Mr. Jack Lowe, Superintendent of Schools for the Prince Rupert School District, who helped transform a proposal into a workable project.

Mrs. Kathy Bedard, Native Indian Education Co-ordinator for the Prince Rupert School District, for her invaluable liaison with school personnel.

Mrs. Debra Cullinane and Miss Valerie Green, for assistance in test administration.

The many teachers and administrators in the Prince Rupert School District who were supportive, enthusiastic, and helpful throughout the project.
The Purpose of the Study

This study was initiated by a concern for the lack of academic success often experienced by Native Indian children in the public school system. This achievement pattern must be examined in a social/environmental context as many Native children do not exhibit differences in cognitive abilities to Non-Native children until they enter the school system. At that point, the verbal deficits of the children, which are a product of socio-economic, cultural-familial influences, have considerable impact on the acquisition of specific academic skills. However, another factor which must also be considered is that Native children may exhibit a relative weakness in sequential information processing which can have significant impact on the development of verbal skills and reading. This is particularly relevant since the medium for instruction in the school system is verbal.

Cognitive skills are developmental and thus emerge at different times. This developmental pattern may differ for children in various socio-cultural groups. However, while children in specific groups can exhibit a lag in the development of specific cognitive skills, these differences are only relative to other groups and are thus not permanent deficits.

If we are to improve the ability of the school system to meet the instructional needs of Native Indian children, we must first determine specific differences in the developmental patterns of academic skills of
Native Indian versus Non-Native children. A further requirement is an understanding of the relationship between academic skill patterns and specific developmental processes such as simultaneous and sequential information processing and neurological maturation. Unless these relationships are investigated, it is unlikely that our instructional and/or remedial efforts will improve the academic achievement of Native Indian children.

Variations in cognitive abilities depends upon numerous factors: health, economic status, lack of social motivation, cultural values, lack of stimulating early experiences, ethnic group membership...and the habitual mode of information processing of the child.

There is a substantial body of literature to suggest that various cultural groups can exhibit differences in their approach to problem solving. These differences may involve unique developmental patterns of skill acquisition rather than the absence of skill development. Native Indian children appear to have cognitive styles that are a product of their cultural/environmental heritage. Thus ethnic/environmental background and not heredity must be seen as the prime determinant of cognitive style.

Previous research has indicated that Native children are visual learners and are less proficient at verbal learning; these differences are shaped by culturally specific experiences that place a premium on spatial, non-verbal processing. Native children have a tendency to habitually use their visual-spatial strengths, even in problem solving.
situations where Non-Native children would utilize verbal skills. This difference in problem solving approach may place Native children at a disadvantage in classroom activities that require the use of verbal processing.

An examination of the way in which children solve problems is more effective if we examine processes rather than abilities. This processing model is the theoretical basis for the Kaufman Assessment Battery for Children (K-ABC); it allows us to compare simultaneous (holistic) processing with sequential (serial) processing. Both of these modes of information processing are available to the individual at any one time and are not hierarchical. An individual child may have a habitual mode of processing which is determined by ethnic/environmental factors. Native children may exhibit culturally determined differences in the development of sequential processing skills that have significant impact on the development of reading competence.

Sequential processing may be more important to the establishment of early reading (decoding) skills; simultaneous processing to the establishment of higher-level comprehension skills. Disabled readers appear to be weak in sequential processing. The lower verbal IQ and poor reading ability of Native children may reflect inefficient sequential processing skills. Indeed, Native children may exhibit a developmental lag in the acquisition of sequential processing skills when compared to non-Native children. If culturally specific developmental patterns of simultaneous and sequential information processing can be determined, instructional programs can be designed to take advantage of the processing strengths of Native Indian children i.e. reading programs
that are based on the simultaneous strengths of Native children at various age levels.

Statement of the Problem

The general problem of this study was to determine if differences in reading performance in school could be explained by differences in information processing abilities. This general problem gave rise to a number of other issues: specifically the development of reading skills and their relationship to information processing and neurological maturation; the relationship between information processing and neurological maturation; and the possibility that specific cultural groups (i.e. Native Indian children) may possess unique patterns of information processing ability.

Importance of the Study

The importance of the study lies in several contexts.

Educational Context

The lack of success often encountered by Native Indian children in the public school system is a continuing concern for Native people and educators alike. The fact that 80% of Native Indian children do not complete a high school graduation as compared to 32% of the non-Native population (More, 1984) is certainly cause for concern. Elementary level Gates-McGinitie and Canadian Test of Basic Skills scores indicate that Native Indian children average about 6 months behind actual grade placement. Reading Comprehension scores, which were close to grade placement during the primary grades, fell sharply to an average 15 month
lag by grades 4-5. CTBS math scores were also approximately 4 months behind grade placement. A further sample of Native Indian high school students reveals letter grades far below those of their non-Native classmates (More, 1984). Terry (1985) indicated that the Native Indian school dropout rate was between 80 and 85%.

Attempts to "solve" this problem often fail to take into account the cultural uniqueness of the Native child. The experiential background of the village/reserve Native child is such that he/she is often at a disadvantage in the highly verbal environment of the public school system. Instructional or remedial efforts should take into account the experiences of the Native child and the possibility that he/she may have a unique information processing style distinct from that of his/her Non-Native peers.

**Experiential Context**

The writer, on the basis of 16 years teaching/counselling experience at the Junior/Senior high school levels in British Columbia, has a strong concern for the lack of academic success of the Native child. However, differences in achievement exhibited by the Native child are felt to be based more on differences in experiences, cultural environment, and motivation, rather than in innate abilities. The writer has not seen consistent evidence of a unique Native Indian "learning style" or "information processing style," but is convinced that Native children have unique motivational/personal differences and educational needs that the public school system is not effectively responding to.
It has often been noticed that Native children have difficulty responding to course materials that does not seem relevant to their experiences or culture. The lack of awareness of Native cultural traditions and history by teachers and Non-Native children serves to further isolate and alienate the Native child. This situation often creates a cultural and personal identity crisis for the Native child which may not be resolved until his/her adult years. Indeed it is often not until the adult years that many Native people are educationally successful, often in a college setting, because the burden of personal and environmental/cultural differences are cast aside. At this stage, there is seldom a concern for individual information processing abilities.

The writer is convinced that given the same environmental experiences and the same economic advantages, the Native child can perform at an academic level equal to that of the Non-Native child. The cultural stereotypes that we have of the academic performance of the Native Indian child is as unfortunate as the economic/environmental conditions that many of these children have to endure.

**Theoretical Context**

Research has indicated that various cultural groups can differ in the way they respond to various cognitive tasks (Das et al., 1979). The "ecological demands" placed on a cultural group may be responsible for cultural variation in the development of perceptual skills (Berry, 1966). The unique perceptual strengths that some cultural groups develop under culturally specific conditions in turn influence their habitual modes of problem solving.
This ecological perspective would explain why Native children appear to exhibit strengths in visual and spatial discrimination (Kaulback, 1984). While these unique abilities place Native children at an advantage in problem solving situations requiring the application of visual-perceptual skills, the Native child faces a disadvantage in problem solving situations involving the use of verbal skills (which predominate in the school system).

In order to understand the way in which children solve problems, we must not look just at differences in abilities but at the way in which they process information. For this reason the simultaneous and sequential information processing model (Das et al, 1975; 1979) based on the work of Luria (1966) was selected as a convenient framework to ask questions about possible differences between Native and Non-Native children. If information processing is indeed culturally specific, we should notice consistent differences in processing skills between Native and Non-Native children. The Native children would be expected to exhibit strengths in simultaneous processing and a maturational lag in the development of sequential processing abilities as an outcome of their cultural heritage. If information processing is ecologically/experientially specific, then we would expect the differences between Village-Native and City-Native children to be greater than the differences between City-Native and Non-Native children. It is the writer's opinion that the latter relationship would be supported by the results of this research.
Description of Terms

1. Ethnicity: This term refers to membership in one of three groups: Native Indian children residing in the north coastal villages of Port Simpson and Hartley Bay (Village-Native), Non-Native children residing in the north coastal city of Prince Rupert (Non-Native), and Native Indian children residing in Prince Rupert (City-Native). Since it was proposed that differences in cultural/environmental experience would be a major influence on the dependent variables, the independent variable Ethnicity was used to represent the cultural/experiential background of the three ethnic groups.

2. Simultaneous and Sequential Processing: This information processing model, suggested by Das, Kirby & Jarman (1975; 1979) is based largely on Luria's (1966) theory of simultaneous and sequential synthesis. The processing approach involves shifting the study of abilities underlying behaviour to an examination of processes or the characteristics of tasks themselves (Messick, 1973).

3. Simultaneous Processing: This mode of information processing involves gestalt-like, holistic processing of individual stimuli arriving at the brain into simultaneous and primarily spatial groups (Das et al., 1975).

4. Sequential Processing: This mode of information processing (which is often termed Successive Processing) involves the integration of individual stimuli into temporal or serial order. Each bit of
information is related to the preceding one, either temporally or logically; problems are solved in a linear manner (Gunnison, Kaufman & Kaufman, 1982).

4. **Neurological Maturation**: Involves the maturation of the central nervous system as measured by the Grip Strength Test. A delay in cerebral maturation can differentially delay the specific skills that are characteristically predominant at different ages (Gaddes, 1980). Children who are delayed in perceptual-motor development as a result of a delay in neurological maturation will experience reading difficulties (Satz et al., 1978).

**Research Hypotheses**

This study was motivated by a concern for the relative lack of academic success often encountered by Native Indian children in the school system. The simultaneous and sequential processing model was selected as the means for examining possible differences in habitual cognitive processing patterns between Native and Non-Native children. Since cognition, neurological maturation, and reading are developmental in nature, the sample was selected so as to display developmental trends throughout most of the elementary school years. Specifically, the research was designed to demonstrate that differences in information processing are probably not due to ethnic group membership, and that reading and neurological maturation display developmental patterns similar to that of simultaneous and sequential processing.
1. There will be no significant differences between the three comparison groups (Village-Native, Non-Native, and City-Native) and the five age groups (ages 8, 9, 10, 11, and 12), and no significant joint effects of Ethnicity and Age, on a weighted linear composite of Simultaneous and Sequential Information Processing scores.

It is anticipated that differences between the Native groups will be greater than differences between the Native and Non-Native groups as cultural experiences have a significant impact on Simultaneous and Sequential Processing. It is also anticipated that all three Ethnic groups will display comparable developmental patterns of Simultaneous and Sequential Processing across the age range of the study.

The simultaneous and sequential model of information processing assumes that both modes are available to the individual at any given time. The decision as to which processing mode to use depends upon the individual's habitual mode of processing information as determined by social/cultural/genetic factors and the demands of the task itself (Das, Kirby & Jarman, 1975). Cummins (1973), and Cummins & Das (1977) reported that various cultural groups may have a proficiency in and a preference for one mode of information processing that is genetically and environmentally determined. Native Indian children may have a characteristic information processing style that involves the use of their simultaneous processing strengths. More (1984) indicated that Native children used Simultaneous Processing on tasks that are usually processed by Sequential means by Non-Native children.
Kaufman & Kaufman (1983c) point out that environment plays a major role in determining how a child performs on both the Mental Processing and Achievement scales of the K-ABC, and further suggest that minorities and majorities do not enjoy the same environmental influences, nor are these influences equal or consistent across various educational levels. While "unstimulating" early environments can have significant effect on the development of cognitive abilities such as perceptual analysis and memory, these effects are not long term (Kagan & Klein, 1973; Kagan, Klein, Harth & Morrison, 1973). Kagan saw the development of cognitive abilities in children as natural responses to maturational factors.

In this way early environment and performance are not predictive of future cognitive development. This would suggest that cultural group differences are not differences in ability or capacity but are differences in maturational rate brought about by environmental factors. Thus maturation/environment, and not ethnic group, must be considered to be the major determinants of psycho-educational growth throughout the childhood years.

If there are significant differences between the two Native Indian groups, this should be interpreted as a slower maturational rate rather than deficits in basic functioning. The Village-Native child, with a restricted experiential background, is probably not as well equipped to respond effectively to Mental Processing Scale items as the City-Native or Non-Native child.
2. There will be no significant differences between the three comparison groups (Village-Native, Non-Native, and City-Native) and the five age groups (ages 8, 9, 10, 11, and 12), and no significant joint effects of Ethnicity and Age, on a weighted linear composite of Simultaneous and Sequential Information Processing Subtest scores.

3. There will be no significant differences between the three comparison groups (Village-Native, Non-Native, and City-Native) and the five age groups (ages 8, 9, 10, 11, and 12), and no significant joint effects of Ethnicity and Age, on a weighted linear composite of Reading Subtest scores (Word Identification, Passage Comprehension, and Reading Understanding).

What is the effect of Ethnic background and Age on the development of reading skills? Do Native Indian children display unique trends in the development of reading skills or is there a greater similarity between the City-Native and Non-Native groups than between the two Native groups?

4. There will be no significant differences between the three comparison groups (Village-Native, Non-Native, and City-Native) and the five age groups (ages 8, 9, 10, 11, and 12), and no significant joint effects of Ethnicity and Age, on a weighted linear composite of Neurological Maturation scores (Grip Strength Dominant Hand and Grip Strength Other Hand).

What is the relationship between Ethnic background or Age and
Neurological Maturation? Do the Native Indian children display unique developmental trends for neurological maturation or is this neurological process more an outcome of cultural setting?

The Grip Strength Test was used as a measure of Neurological Maturation. Grip Strength is an established subtest on the Reitan-Knove Sensory-Perceptual Examination, which is part of the Halstead Neuropsychological Test Battery for Children (Selz, 1981). Spreen & Gaddes (1969) suggested that grip strength normative data would be useful for indicating the presence of neurological dysfunction. Gaddes (1980) indicated that the Esthesiometer Test and the Grip Strength Test (among other sensorimotor tests) were failed by the greatest number of learning disabled children and that these tests should be considered to be sensitive indicators of central nervous system dysfunction.

Statistical Hypotheses.

The principal statistical hypotheses of the study are:

1. Main effects:
   \[ H_{01} : \Sigma \alpha_i = 0 \] (age effects)
   \[ H_{02} : \Sigma \beta_j = 0 \] (ethnicity effects)

   Interaction effects:
   \[ H_{03} : \Sigma \alpha \beta_{ij} = 0 \] (interaction effect)

   There will be no statistically significant difference at the \( \alpha = .05 \) level between mean scores on a weighted linear composite of Simultaneous and Sequential Information Processing tasks for the three
comparison groups (Village-Native, Non-Native, and City-Native), and all ages (8, 9, 10, 11, and 12), as well as no significant joint effects of Ethnicity and Age.

2. Main effects:

\[ H_0: \sum \alpha_i = 0 \]  \hspace{1cm} \text{(age effects)}

\[ H_0: \sum \beta_j = 0 \]  \hspace{1cm} \text{(ethnicity effects)}

Interaction effects:

\[ H_0: \sum \alpha \beta_{ij} = 0 \]  \hspace{1cm} \text{(interaction effects)}

There will be no statistically significant difference at the \( \alpha = .05 \) level between mean scores on a weighted linear composite of Simultaneous and Sequential Information Processing subtest tasks for the three comparison groups (Village-Native, Non-Native, and City-Native), and all ages (8, 9, 10, 11, and 12), as well as no significant joint effects of Ethnicity and Age.

3. Main Effects:

\[ H_0: \sum \alpha_i = 0 \]  \hspace{1cm} \text{(age effects)}

\[ H_0: \sum \beta_j = 0 \]  \hspace{1cm} \text{(ethnicity effects)}

Interaction effects:

\[ H_0: \sum \alpha \beta_{ij} = 0 \]  \hspace{1cm} \text{(interaction effects)}

There will be no statistically significant difference at the \( \alpha = .05 \) level between mean scores on a weighted linear composite of Reading tasks for the three comparison groups (Village-Native, Non-Native, and City-Native), and all ages (8, 9, 10, 11, and 12), as well as no significant joint effects of Ethnicity and Age.
4. Main effects:
   \( H_01 : \sum \alpha_i = 0 \) (age effects)
   \( H_02 : \sum \beta_j = 0 \) (ethnicity effects)

Interaction effects:
   \( H_03 : \sum \alpha \beta_{ij} = 0 \) (interaction effects)

There will be no statistically significant difference at the \( \alpha = .05 \) level between mean scores on a weighted linear composite of Neurological Maturation tasks for the three comparison groups (Village-Native, Non-Native, and City-Native), and all ages (8, 9, 10, 11, and 12), as well as no significant joint effects of Ethnicity and Age.

Method of Study

Chapter III will present the Method of Study, including: a description of the population of (Tsimshian) Native Indian and Non-Native children; the sampling procedure and a description of the subjects in the sample; the limitations of the sample; a discussion of the instrumentation, including a listing of the dependent and independent variables and reliability/validity of the instruments; administration procedure, scoring, transformation of scores, and data collection and processing; and a discussion of the research design and method of analysis (canonical analysis, ANOVA, and post-hoc analysis) completes this chapter.
Limitations of the Study

This research was conducted in the North Coastal region of British Columbia surrounding the city of Prince Rupert. The Native Indian children selected were all members of the Tsimshian tribal group predominant in that region and lived either in the city of Prince Rupert or in the coastal villages of Port Simpson and Hartley Bay. The non-Native children all resided in Prince Rupert. A non-Native sample comparable to the village Native children was not obtainable.

All children in the study were volunteers and resided in Prince Rupert, Port Simpson, or Hartley Bay, B.C. The Non-Native sample was randomly assigned but this was not possible with the two Native groups because of the sample sizes. However, the participation rate was high enough in the two Native samples to allow for confidence in the representativeness of these samples. Since the children represented the full range of abilities in each school and there was only one test session, it is unlikely that there would be any internal threats to validity.

Since many of the Native children enrolled in the city schools in Prince Rupert were not of Tsimshian tribal origin, it was necessary to obtain the City-Native sample from 6 elementary schools in Prince Rupert. The most difficulty was experienced in obtaining the 9-year-old City-Native children. There is a possibility, that this 9-year-old City-Native group may not be fully representative of City-Native children in Prince Rupert.

One might further question whether or not the City-Native sample is representative of City-Native children as they were all volunteers and
not randomly assigned. Thus it is possible that the City-Native sample may be biased because of self-selection or parental selection. Jensen (1984) suggested that such a voluntary selection process results in a larger proportion of children from lower SES homes failing to return parent permission forms. Permission is also less likely to be granted for children of low ability or poor adjustment toward school. On the other hand, parents of lower ability children might be more apt to participate in the study as they would be more unaware or unconcerned with the nature of school-based activities. The overall impact of voluntary selection on the city Native sample is unknown, however practical considerations left no other alternative.

This is not seen as a problem with the Village-Native children as there is very little variation in SES in the Native village communities and the majority of the 8-12 year-old children in the village schools volunteered for the study. The proportion of Non-Native children volunteering for the study was so high (80-90% in the two schools) that random assignment was utilized in order to reduce sampling bias.

It is assumed that the findings of the study can be safely generalized to Tsimshian children in British Columbia (most of whom live in the North Coastal area) and is reasonably suggestive of Native children throughout the province. Future replications of this research will have to determine if these findings apply to Native children from other tribal groups and in other parts of the Province of British Columbia.
Native Indian Culture and School Achievement

Native Indian children often experience some difficulty with school achievement. This lack of success, despite recent innovations in Native curriculum development, remains a major concern for educators and Native people alike.

More (1984) has indicated that at the present time in B.C. approximately 80% of Native Indian children do not complete a high school graduation compared to approximately 32% of the Non-Native population (based on Department of Indian Affairs and Northern Development figures of Native students normally resident on reserves...calculated by comparing the number of grade 12 students with the number of grade one students twelve years earlier, with corrections for students repeating grades). Terry (1985) indicated that the Native student drop-out rate was between 80 and 85%; the national drop-out ratio has been reported previously as high as 90%, a finding which prompted the Native Indian Brotherhood to call for Indian control of the education of Indian children (Kainai News, 1976; 1977).

Figures provided by the Department of Indian Affairs indicate that the rates of retention for Natives from grades 1-12 from 1958-59 to 1969-70 varied from 7.7% in Quebec to a high of 18.4% in Ontario. "Usually 50% of Native children beginning grade one drop out before grade 8 or 9" (Stanbury, 1975, p. 108). In B.C., 79.6% of all people whose
language was Indian or Inuit and who were over 20 years of age had no more than an elementary school education as compared to 36.8% for all Canadians.

Studies of in-school achievement commonly show that Native children lag behind their non-Native classmates and fall further behind with increasing years in school (Berry, 1968). Research on adolescent American Indian children indicates a marked decrease in academic achievement by the 5th or 6th year in school (Zintz, 1963). So dramatic is this decrease that the causal factors cannot be limited to lack of knowledge. Collier (1973) described Eskimo students as “giving up” in the classroom. Wax (1967) examined the high dropout rate among Sioux adolescents who saw themselves as having been “kicked out” or “pushed out” of an educational system that was at odds with their own culture. Coleman (1966) indicates that the academic performance of American Indian and Alaskan Native children in the first few years of school appears to be only slightly lower than that of non-Native children. This mild disparity suddenly widens in about the third or fourth grade when large discrepancies in achievement relative to non-Native children become common across all subject areas. At the high school level, Indian dropout rates tend to exceed 50% (Weinberg, 1977).

Elementary level Gates-McGinitie and Canadian Test of Basic Skills scores indicate that Native Indian children in Merritt, B.C. averaged about 6 months behind actual grade placement. Reading Comprehension scores which were close to grade placement during the primary grades, fell sharply to an average 15 month lag by grades 4-5. CTBS Math scores
were also approximately 4 months behind grade placement (More, 1984). A sample of Native Indian high school students reveals letter grades far below those of their non-Native classmates; a majority of the Native students' letter grades were below the failure level (More, 1984). As Indian children advance in grade level, they learn that their classroom performance is being judged, and that by the school's standards they are deficient. It is for this reason that they reject the importance of performance on classroom activities and tests (Deyhle, 1983).

It appears that some Indian children, reared in traditional nurturing surroundings, enter schools that expose them to cultural disparities. Under these early pressures, they may develop into children who are judged by the majority culture as shy, non-competitive, and academically deficient (McShane, 1983).

It is tempting to dismiss these differences as artifacts of the testing situation itself. It can be argued that current testing procedures assume that all children have assimilated into the "white, middle-class culture," that "the English language is appropriate for administering such tests to all students, and that one single distribution curve can be used to classify the behaviour of all children" (More & Oldridge, 1980, p. 53). This argument views the school system as "Anglocentric," monocultural, and biased toward middle-class customs and lifestyles. In this way the language-based deficiencies exhibited by Native children on "Anglo-normed" tests may be largely an outcome of culture and cognitive style differences (McShane, 1982).
Downing, Ollila & Oliver (1975) noted that the development of children's concepts of the function of writing and their concept of the units of printed language was related to socio-economic class. The way in which social class background may influence the cognitive aspects of reading readiness has been described by Downing & Thackray (1971). For example, there are likely to be fewer discussions of writing, print, spelling, books and other aspects of literate behaviour in the lower socio-economic class home than in the higher socio-economic class home. Bowd (1974) suggested that poor verbal ability and school achievement may be a function of the quality of English spoken in the home.

Hawthorne (1966) reported that many Indian parents carried out only restricted conversations with their children, frequently answering in monosyllables. In addition, the English spoken by the adults was often inaccurate and dependent upon a limited vocabulary. While the verbal deficits of Indian children may be seen as the outcome of cultural-familial influences, these deficits may also be the result of their relative weakness in sequential processing as verbal skills are more highly related to sequential than to simultaneous processing at an early stage of their development. If we accept the existence of a sequential processing deficit in Native Indian children, then even low-achieving non-Indian children should be superior to Native children not only in word-related sequential tasks, but also on tasks which do not involve words (Das, Kirby & Jarman, 1979).

Language deficiencies have both educational and cultural implications
as language can be used as a "symbol" of ethnic strength. Because the medium for instruction in the schools is verbal, these language deficiencies inhibit school learning (Brooks, 1978). It has been suggested that poor knowledge of English linguistic rules, unique patterns of interpersonal communication, adherence to tradition, cognitive styles, and otitis media are factors responsible for the Native Indian visual-perceptual learning style (Mickelson & Galloway, 1969, 1973; Sabatino, Hayden & Kelley, 1972; St. John, Krachev & Bauman, 1976; Sattler, 1982; Schubert & Cropley, 1972).

**Economic Disadvantage and Learning**

It can be argued that Native Indians are the most economically disadvantaged group in Canada. The average per capita earned income on reserves is less than $2000.00 per year with 41% of all Indian families living on welfare (as compared to 3.7% for the total Canadian population). Unemployment averages 55% with seasonal variations rising to 95% on some reserves. "Many (Native) families live below the poverty line in substandard housing and often eat poorly" (Terry, 1985). A study done on occupational prestige among a variety of ethnic groups in Canada found Native people to be so anomalously low on the scale that the researchers thought that there must be "structural discrimination" involved (Lanpher, Lam, Clodman & Somogyi, 1980).

The average age of death (including infant mortality, which obviously skews the mean) for Natives is 41.5 years for males and 43.3 years for females with violent deaths occurring 3-6 times more frequently than in
the non-Native population (Canadian Association in Support of Native Peoples, 1976). Terry (1985) indicated that 4 out of 10 Indian people die violent deaths and that Indian people are also admitted to hospital twice as often as non-Indian people. Suicide among Indian youths is 6 times that of non-Indian teens. Orwen (1985) reported that:

The incidence of violent death among Native people is nearly five times that of the non-Indian population, according to Federal Government statistics. More than twice as many Natives commit suicide as non-Natives. Indian babies are twice as likely to die before their first birthday than non-Natives. The rates of alcoholism among Indians is considerably higher than the national average. B.C. Indians suffer among the highest death rates in Canada, and their infant death rate are the highest. (p. 16)

It is not inaccurate to conclude that many Native Indian children experience detrimental conditions that place them at a greater disadvantage and thus educationally at risk when compared to more fortunate groups of children. An examination of the cognitive achievement differences of any minority group must always take into account economic-social-cultural factors that influence developmental patterns in abilities and skills. Thus "economic poverty, poor nutrition, inadequate health care, poor housing, crowded living space, and access only to lower quality education programs and experiences are factors not supportive of, and may impede learning" (McShane, 1983, p. 34). Kagan & Klein (1973) express concern at the:

Unfortunate tendency to regard the poor test performances of economically impoverished, minority-group, 6-year olds...as indicative of a permanent and, perhaps, irreversible deficit in intellectual ability as a difference in quality of function rather than a slower maturational rate. (p. 958)
Basic cognitive competencies (i.e. information processing) in contrast to culturally specific ones (i.e. reading), are developmental and thus emerge at different times. In this sense children retain the capacity for actualization of their abilities until a late age; thus we cannot speak of children as lacking the intellectual capacity for self-actualization and cognitive growth. When educators note that Native Indian children seem to remain permanently behind more economically advantaged middle-class children on intellectual and academic performance, they are referring to relative differences in the culturally specific skills of reading, mathematics, and language achievement. However, these relative differences are the product of the rank ordering of scores on achievement and IQ tests. The fact that the relative differences on these abilities is stable (exhibits the same rank order although the gap between Native and Non-Native children widens) from age 5 on, does not mean that Native children are not growing intellectually (when compared to themselves), often at the same rate as economically advantaged Non-Native, middle-class children (Kagan & Klein, 1973). Thus separate maturational factors appear to set the time of emergence of basic intellectual abilities in children. While these basic intellectual abilities determine the mastery of culturally specific skills, i.e. reading, arithmetic, and language, the child must be exposed to or taught these activities directly (Das et al., 1979). The maturational factors that determine this process may not be the same for every cultural group or for every member of a specific group. "Variations in intelligence, then, can be large or small depending on the contributions of nongenetic components - life's experience, education, and opportunity for growth are some of these" (Das et al., 1979, p. 7).
The almost epidemic prevalence of middle ear disease (otitis media) in young Indian children may result in hearing loss and possible language problems. In a review of over 100 articles concerning the prevalence, etiology, psychoeducational sequelae, and service delivery problems of otitis media in American Indian children, McShane (1982) reported the potential debilitating links between this middle ear disease and hearing loss, language delay, cognitive deficit, and educational delay. As high as 75% of the children in many Native Indian populations may experience multiple episodes of otitis media, the single leading identifiable disease among Native Indian populations, with the greatest frequency of episodes usually occurring between birth and 5 years of age. Kaplan, Fleshman & Bender (1975) suggested that a consequence of this middle ear infection is cognitive and educational delay. "The high incidence of otitis media (and consequent hearing loss) may affect psycholinguistic development, reduce auditory-verbal reception, association, sequencing, and expressive abilities" (McShane & Plas, 1984, p. 70). McShane & Plas (in press) found significant correlations between mother-reported frequencies of ear infections and reduced linguistic and cognitive abilities for young Ojibwa children. One of the outcomes of middle ear infection is that it may predispose Native Indian children to overuse visual-spatial cognitive strategies, particularly in terms of processing language-oriented material.

Native Indian children may also be at higher risk than Non-Native children for visual difficulties. Hamilton (1976) found six times as many Native Indian children than Non-Native children entering the school system with a visual handicap (usually not detected before the fourth
grade). Even when their vision problems were detected and treated, 57% of Native Indian children versus 22% of non-Native children did not wear their glasses. Other highly prevalent health problems affecting Native children have also been described (Wallace, 1973) in light of their impact on learning functions (i.e. low birthweights, poor nutrition, scarlet fever, pneumonia, tuberculosis, and other preventable infectious diseases).

Economic poverty has numerous negative manifestations, not the least of which is the decreased availability of reading materials and other sources of cognitive stimulation. Native children may be handicapped by factors such as language, deficiencies in motivation and lack of self-confidence (More & Oldridge, 1980). Vernon would remind us that Native children are handicapped by linguistic and motivational weaknesses (1969). The fact that Native children come from a culture with no tradition of written language is probably central to this issue. Indeed, the use of writing as a form of communication is not common in the Native culture. Thus it is not surprising to find that Non-Native children obtain higher scores on measures of reading readiness than Native children, and that Native children experience greater difficulty than Non-Native children in the development of reading skills (Downing et al., 1975).

While there have been successful Native medium language programs, i.e. Kativik School Board in Arctic Quebec and the Eastern Arctic of the Northwest Territories, and until recently, a longstanding Cree medium program at Cross Lake, Manitoba (Burnaby, 1984), the major obstacle
that Native peoples face in developing language programs is that:

Native languages do not have all the facilities that highly literate languages like English have, for example, a standardized writing system, dictionaries, grammars, curriculum outlines for content subjects, textbooks, and support reading materials. Even resources such a typewriter elements and Letraset can hamper the work of using Native languages as media or subjects of instruction. (Burnaby, Nichols & Toohey, 1980, p. 16)

Unfortunately, the gap between a cultural minority child and the cultural majority child begins to grow with age and exposure to normal classroom learning (Jensen, 1977). Hunt (1961) stressed the importance of early experience on intellectual growth. Haywood & Tapp (1966) concluded that an enriched early environment increases intelligence, whereas an impoverished environment may lower intellectual level. While the lower competence of disadvantaged minority groups has been attributed to such factors as genetic causes, lack of stimulating early experience, poor nutrition, social motivations, and cultural values, cognitive style or habitual mode of information processing favoured by a cultural group may in fact account for the lowered performance of the disadvantaged child (Das, 1973).

**Native Indian Culture and Cognitive Style**

Cognitive style can be defined as individual differences in habitual ways of processing information. Various cultural groups can differ in their approaches to cognitive tasks, information processing can be seen as cognitive style within the context of cultural-ecological influences (Das, Kirby & Jarman, 1979).
Berry (1966) argued that the "ecological demands" placed on a group of people, plus their adaptation to this ecology, would lead to the development of certain perceptual skills. Specifically, Berry argued that people who inhabit ecologies where hunting was the mode of sustenance would develop perceptual discrimination and spatial skills adapted to the ecological demands of their hunting lifestyle. Berry (1966) further indicated that Canadian Eskimos obtained high scores on visual-spatial tasks; a finding that he related to the ecological demands of the Eskimo lifestyle (the necessity of adaptive cultural behaviour was the source of their visual-perceptual cognitive style).

It is evident that the Inuit must develop certain perceptual skills merely to survive in their situation....He must first of all in order to hunt effectively develop the ability to isolate slight variations in visual stimulation from a rather featureless array; he must learn to be aware of minute detail. Secondly, in order to navigate effectively in this environment he must learn to organize these small details into a spatial awareness, an awareness of his present location in relation to objects around him. (Berry, 1966, p. 212)

Thus it appears that ecology or environment helps to determine or develop the range and strength of perceptual skills differentially across cultures.

Kleinfeld (1970) reinforced Berry's view of ecology as the determining factor in the development of perceptual skills when she demonstrated that Inuit children were superior to urban white children in their ability to recall complex visual patterns. Kleinfeld (1970) concluded that her findings were consistent with the literature in indicating highly acute visual skills in Inuit children.
While Native Indian children would be expected to display well-developed spatial and visual discrimination abilities, implicit in this expectation is the assumption that as the traditional lifestyle diminishes in importance across samples ranked in terms of this ecological dimension, the visual discrimination and spatial skills will also diminish. However, there remains numerous examples of urban Native children who have developed perceptual abilities similar to those of other Native children living more traditional lifestyles. Berry (1971) indicated that urban Inuit children had outperformed rural (traditional) Inuit children on measures of visual discrimination. The retention of these perceptual abilities may be due to a lag in cultural adaptation. This, however, would suggest that factors other than ecological/environmental factors can have some influence on the development of visual perceptual skills. Indeed, child rearing practices may in themselves initiate the visual learning style of Native children. Kaulback (1984) indicated that:

Researchers are now beginning to study the culturally distinct activities associated with child rearing and there is mounting evidence that child rearing traits, irrespective of a society's orientation towards traditional or non-traditional activities, may account for the distinctly visual style of learning among Native children. (p. 32)

While the economic and cultural lifestyle of Native communities have undergone considerable change, the methods of child rearing have remained more-or-less constant as has the nature of the interaction between Native parent and child. The changes that do occur in any given culture are very slow and may lag behind ecological change (Swampy,
1982). Thus child rearing practices and the methods of interaction between mother and child can be assumed to have remained relatively constant despite cultural change. The outcome of such interaction was and still is visually acute perceptual skills among Native children (Rohner, 1965). The literature on traditional and contemporary Indian and Inuit cultures contain many examples of the relationship between child rearing practices and perceptual skills (Hilger, 1959; Cazden & John, 1969; Kleinfeld, 1970; Rohner, 1965).

In comparing American Indian children to non-Indian children, Scribner and Cole (1973) found that both groups were affected by the content of the stimulus materials. Communicative accuracy was closely related to the functional importance placed on making fine distinctions between the particular item used in one's prior cultural experiences. Thus the more familiar and culturally relevant the situation being observed, the more likely the people are to perform competently. However, Indian children have not performed competently in the school system because of a number of these socio-cultural factors. Indian language issues, poor teacher preparation, lack of Indian role models, culturally-biased tests, lack of parental involvement, and low expectations of Indian children held by school staff have been offered as possible contributing factors for the failure of Indian children. Perhaps most significant has been the lack of curriculum that accurately reflects the experiential, linguistic, and cultural background of the Indian student (Butterfield, 1983). The use of curriculum materials unrelated to Native cultural awareness and instructional methods unsuited to Native learning and motivational styles further restricts the academic performance of
Native children. Downing et al., (1975) observed that:

Children's cognitive clarity regarding the functions and the skills of literacy is influenced by socio-cultural factors. Probably the specific causal relationship depends on the extent to which an environment provides experiences to stir the child's curiosity and give him sufficient reliable information for discovery of the appropriate linguistic concepts. (p. 315)

Nerlove and Snipper (1981) indicate that "the circumstances of daily life are important sources of cultural variations which have implications for cognitive development. Different learning environments produce different cognitive outcomes" (p. 440). However, the same opportunities for learning and the development of problem solving strategies are not provided by every culture.

If we are willing to assume that some facets of experience make some individuals more "intelligent," then a culture that provides these experiences is going to produce more "intelligent" members who will attain higher levels of achievement in the educational system (Bock, 1980). Thus when a Native child's general background experiences differ from those of non-Native children, then differences in achievement should be expected, but these differences are based on experiential background rather than ethnic group (Salvia and Ysseldike, 1981).

Super (1981) concluded that except for conditions of minimal stimulation and/or malnutrition, there is no cultural group that shows more rapid general cognitive development than another. Indeed, studies of memory skills show that traditional people within various settings often have excellent memories for spatial and visual information.
(Kearins, 1981; Meacham, 1975). There is also evidence to suggest that
general cultural differences in memory are very specific and are highly
similar to the kinds of tasks required of children in schools (Sternberg,
1982). However, school learning might build a bias toward using spatial
reasoning ability, whereas in pre-literate cultures memory ability might
be more in demand. Thus "it is plausible that cultural or social class
preferences for the use of reasoning or memory may exist as they do for
simultaneous or successive synthesis" (Das, Kirby, & Jarman, 1975, p.
98).

**Traditional Lifestyle and Learning Style**

The various elements of traditional Indian life contributed toward
shaping the Indian culture and in turn the Indian personality.

Beadwork, weaving, and basketmaking all teach a way of seeing the
world in a different way, of being able to visualize what does not yet
exist, learning to see how patterns can be made or taken away to
build something that can be recognized or understood. (Tafoya, 1982,
p. 46)

The "old ways" which often involved observation, are being rediscovered
by Indian people to preserve and pass on their cultural heritage.

But the fire has not changed. The flames still burn bright and hot and
steady. The smoke still rises and the smell of pine or oak or maple
lingers on. Gaze into the fire for it is constant. Gaze into the fire
and feel the warmth. Gaze into the fire and rekindle your spirit and
listen to the ways of the old. (Henry Red Bird, in Butterfield, 1983,
p. 48).

This image of the "old way" is perhaps descriptive of the most
traditional Indian cultures. Certainly there were and continue to be differences between Indian cultures in their reliance on traditional cultural practices. Early exposure to Non-Native cultures would provide some Native groups with the opportunities to become familiar with non-traditional cultural experiences and to develop relevant and necessary learning skills. It is anticipated that these differences will be apparent in an examination of the Village-Native and City-Native children as the cultural experiences of these two groups are quite different.

Native children acquire skills by observing and imitating the performance of their family elders. This visual learning process minimizes the need for verbal explanations. Deyhle (1983) indicates that Navajo children repeatedly observe an activity, review the performance in their minds until they are certain that they can do the task well, and only then undertake its performance. "A reluctance to try too soon and the accompanying fear of being 'shamed' if one does not succeed may account for the seemingly passive, uninterested and unresponsive attitude of American Indian students" (Longstreet, 1978, p. 28). Philips (1972) reported that the mode of instruction of Native Indians ignored failure and required long periods of observation preceeding performance. Visual observation and an awareness of the environment were survival skills demanded by the traditional Native ecology (Berry, 1966). Thus Native children enter the classroom having learned primarily by observation, listening, and supervised participation (Deyhle, 1983). Cazdon and John (1968) characterized this style of learning as "learning through looking." Other researchers have called it observational learning.
or learning by doing. The impact of this observational/visual learning style has been quite profound:

Upon the development of certain skills within the perceptual repertoire of Native children....Stimulated, as they are, to observe accurately, these children have acquired the ability to organize their observations and form concepts from them. The children have, in other words, learned to learn through visual means. (Kaulback, 1984, p. 33)

While all cultures create conditions for visual learning, many Native cultures create unique opportunities for visual learning that may minimize the need for verbal instruction. Native cultures passed on stories and legends primarily by verbal means but other forms of learning were highly visual because of the child's close proximity to the observable action. While much of the information that a Native child was expected to learn involved both visual and verbal components, there was perhaps an emphasis on the ability to visually encode visual and verbal information due to the lack of a written language. This in turn would result in the development of strengths in visual imagery and visual learning.

Compare the many rich sources of information available to the child who learns to weave by watching and doing; he sees particular bits of material varying in width and flexibility, feels their tension and resistance, compares his physical movements to those of the modeler and integrates all these inputs from different sense modalities into his cognitive scheme of what weaving is all about. Learning to weave by hearing a discourse on it is quite a different situation. (Scribner & Cole, 1973, p. 556)

In this way, instruction in the Native cultural context involves discovery and hands-on experience; even the ideas and values of the
Native culture are transmitted in this manner. Learning becomes an active process involving adult modeling and supervision (John, 1972; Tafoya, 1982; Scollon & Scollon, 1983; Marashio, 1982; Philips, 1972; Ross, 1982; and Kaulback, 1984). Native children are:

Expected to constantly observe the world around them and learn from it. From this it can be seen that one does not "teach" a child to learn. This amount of intervention in the child's autonomy would risk forever destroying the child's ability to observe and learn from his own motives. (Scollon & Scollon, 1983, p. 101).

Ethnographic studies covering a wide diversity of tribal and geographic settings generally have reported that Indian students speak less frequently, have different patterns of gaze, and are uncomfortable with individual performance (Greenbaum and Greenbaum, 1983). North American Indians are reported to prefer cooperative versus competitive activities, decisions by consensus rather than exertion of individual authority, an emphasis on watching and waiting over verbal participation, avoidance of conflict rather than direct confrontation, and a dislike of individual public performances (Basso, 1970; Bigart, 1974; Brown, 1980; Erickson and Mohatt, 1982; Lurie, 1971; Miller and Thomas, 1972; and Paul, 1980).

Guilmet (1979) noted that while Native and Non-Native children attend equally to the teacher, they do so through different sensory channels with Native children relying more on the visual and Non-Natives more on the verbal. Philips (1972) suggested that Native Indian patterns of classroom interaction emphasized visual over verbal attending. Even in playground activities, Native Navajo children were less verbal and had
correspondingly higher rates of non-verbal gazing than Non-Native children (Guilmet, 1981). Philips (1983) and Wax et al., (1964) indicated that a pattern of less talk and more visual attending characterized the behaviour of younger Indian children.

Scollon and Scollon (1979) indicated that the style of communication of Canadian Native Indian children was one that generally avoided question asking as a verbal strategy in day-to-day speech habits. Black (1973) reported that Ojibwa students in Ontario considered it impolite to ask direct questions and neither asked nor answered such queries in the same way as Anglos. Direct questions, both in and out of the classroom were often met with complete silence. In contrast, Lassoa (1977) noted that there was much more verbal interaction between mother and child in the Anglo-American household than in other cultural groups. Such cultural differences in verbal interaction between mother and child may be the basis for cultural differences in learning styles. Thus while the distinction between Native and Non-Native child-rearing practices is far from conclusive, Kaulback (1984) has (perhaps simplistically) illustrated the nature of this relationship by concluding that these differences have resulted in the development of two noticeably different styles of learning.

Whereas white children, by virtue of their upbringing and their linguistic exposure, are oriented towards using language as a vehicle for learning, Native children have developed a learning style characterized by observation and imitation. (Kaulback, 1984, p. 34)

Some cultures may give systematic practice to thinking outside one's common experience. In this way some cultures produce more powerful
and general modes of thought (Price-Williams, 1975). Messick (1980) concluded that ethnic groups, independent of SES, display characteristic patterns of abilities that are strikingly different from one another. The claim that all human populations are in fact identical on all cognitive abilities is an egalitarian fallacy; as Jensen (1980) points out, such an assumption is totally and scientifically unwarranted. There are simply too many examples of specific abilities and even sensory capacities that have been shown to unmistakably differ across human populations, i.e. the predicted interaction of race and forward versus backward digit span is highly significant even when race is considered independently of SES (Jensen and Figueroa, 1975). Thus our intellectual processes are shaped by exposure to cultural and environmental experiences. These experiences are not only reflected in what we think, but also in the structural operation or mode of our thinking (Luria, 1976).

Culturally Determined Learning Strengths of Native Indian Children

Relatively few studies have addressed themselves to the issue of the learning strengths of Native Indian children (Brooks, 1978). Vernon (1969) and Weitz (1971) have systematically examined the cognitive styles of people in traditional cultures: Vernon (1965) demonstrated that Native children performed relatively better on non-verbal tests of aptitude than on verbal tests; and that Inuit and Indian children are strongest in perceptual and spatial abilities (Vernon, 1969). MacArthur (1962) showed that Indians and Metis scored lower in scholastic aptitude than whites, but that Native performance was considerably better on non-language (culture-reduced) tests. Scaldwell, Frame and Cookson
(1984), and McShane & Plas (1984) indicate that Native children have superior abilities on WISC-R visual-spatial tasks; a similar finding to the McShane's & Plas 1982 article which indicated that Indian children display a significant discrepancy between verbal and non-verbal abilities with verbal abilities lower than those for Non-Native children and non-verbal abilities equal to or above those for Non-Natives.

Beery (1966); Browne (1984); and Kleinfeld (1971) also found that Native Indian children were superior on the WISC-R Performance subtests but exhibited depressed scores on WISC-R Verbal subtests. Other researchers have also reported significantly higher Wechsler Performance than Verbal IQ scores for numerous American Indian groups (Cundick, 1970; Hynd, Quackenbush, Kramer, Conner, & Weed, 1979; St. John, Krichev, & Bauman, 1976; Teeter, Moore, & Peterson, 1982; Zarske & Moore, 1982). However, other researchers suggest that these tests, all of which emphasize verbal reasoning skills, tend to discriminate against Native children as many of them do not have the level of understanding of the English language necessary for success on the tests (Jamieson & Sandford, 1928).

Naglieri (1984) indicated that Navajo children obtained a significant difference between WISC-R Full Scale IQ and Kaufman Assessment Battery Mental Processing because they score lower on the Verbal than on the Performance scales. The reoccurring cognitive strengths of Native Indian children reported in the recent literature (McShane & Plas, 1984; Browne, 1984; and Scaldwell et al., 1984) have been interpreted to indicate a Native Indian visual-spatial cognitive pattern; a pattern that
is in part determined by the unique characteristics of the Indian culture and lifestyle. Sattler (1982) states that American Indians consistently demonstrate a unique pattern of scores on the Wechsler Intelligence Scales, suggesting that they possess relative strengths in visual perception and relative weaknesses in language. McCartin & Schill (1977) indicated that "If performance on tests is any indication, it appears that the American Indian child has greater facility in learning when visual methods of instruction are used..." (p. 15). Kaulback (1984) concluded that "Indian and Inuit children are most successful at processing visual information and have the most difficulty performing well on tasks saturated with verbal content" (p. 30).

The typical method of presentation in the classroom is verbal, and therefore creates difficulties for the Native child which other methods of presentation might avoid. The process of education almost always favours those who are highly verbal, much to the detriment of Native children: "observation is a very limited (learning) technique in the overwhelmingly linguistic environment of the school" (Scribner & Cole, 1973, p. 556). MacArthur (1969) has suggested that the relatively higher capabilities of Native pupils in reasoning from non-verbal stimuli indicates that more extensive use of non-verbal approaches as media of instruction would be appropriate. MacArthur also argues that the objective of instruction should be the development of both verbal and non-verbal abilities. In this way, effective classroom learning styles and context compliment or overlap with the learning styles and context present in the child's nonschool environment (Deyhle, 1983). Brooks (1978) indicates that "concept learning (the heart of the curriculum) is
influenced by different ability patterns" (p. 64). Unfortunately, modern schools tend to emphasize the verbal at the expense of the non-verbal, thus the school system reinforces children who are good at verbal reasoning and language.

It has not only been demonstrated that Native Indian children are stronger in spatial abilities but also that they use spatial abilities in problem solving situations when Non-Native children might use verbal abilities (Brooks, 1978). More (1984) reported that non-Native children appeared to use simultaneous or sequential processing depending on the appropriateness of the processing mode to the subtest materials; however, Native children appeared to use simultaneous processing whether or not this processing mode was appropriate for the subtest materials. This would suggest that children, regardless of cultural group, tend to use their strongest cognitive abilities to solve problems. The characteristic problem solving style of Native Indian children is best described as non-verbal versus the more verbally oriented problem solving style of Non-Native children.

Evidence is now available to suggest that a particular mode of information integration such as sequential processing, may be used by certain non-white groups in tasks which usually elicit simultaneous processing in white children. Differences in cognitive style thus exist among culturally different populations and among subpopulations within any given culture (Das et al., 1979, p. 117).

Brooks (1978) found it not unreasonable to assume that individuals will use their strongest abilities when learning or solving problems and, therefore, the classroom is likely to contain activities which for the
non-Native teacher are verbal tasks but which for the Native student are spatial or non-verbal tasks.

It would appear, then, that many Native children, by virtue of their predisposition to a visual style of learning, may be handicapped in their ability to succeed in school because schools and teaching methods tend to cater to the auditory learner. In light of this, there is a definite need to critically examine the methods, programs and materials we use in Native schools and test for their effectiveness. The basic question that we must now ask ourselves is - are there better way's (Kaulback, 1984, p. 35).

The Simultaneous and Sequential Processing Model of Cognitive Abilities

The study of intelligence has recently seen a shift from the study of abilities underlying behaviour to an examination of processes or the characteristics of tasks themselves (Messick, 1973). This shift has been encouraged by a recognition of the total inappropriateness of standardized psychological techniques for assessing cognition across cultures. Even within cultures problem solving involves familiar forms of interaction because of culturally organized contexts for thinking (Lave, 1980). The cognitive theories of Sternberg, Piaget and Das emphasize this qualitative approach.

A number of theoretical dichotomies have been proposed in the more recent models of the intellect (Naglieri, Kamphaus & Kaufman, 1983): verbal and non-verbal (Wechsler, 1958), fluid and crystallized (Cattell, 1963), rational and metaphoric (Bruner, 1965), successive and simultaneous (Luria, 1966a), convergent and divergent (Gazzaniga, 1970), and analytic and holistic (Ornstein, 1972).
The process model suggested by Das et al., (1975; 1979) is based largely on Luria's (1966a; 1966b) theory of simultaneous and sequential (successive) synthesis, a mental processing dichotomy that has also been labeled serial-parallel or sequential-multiple (Neisser, 1967), analytic-holistic (Ornstein, 1972), controlled-automatic (Shiffrin and Schneider, 1977), and prepositional-appositional (Bogen, 1975).

Factors identifiable as simultaneous and successive processing have emerged in a large number of studies, and we have attempted to explore their relationships to traditional models of abilities, intelligence and language. (Das, Kirby, & Jarman, 1979, p. 777)

Interest in the level of performance has been supplanted by a study of the processes of problem solving or the use of cognitive mechanisms to acquire and retain knowledge and to solve new problems (Kirby and Biggs, 1980; Snow, Federico & Montague, 1980).

Simultaneous and sequential integration are, of course, not new concepts. They were presented by Sechenov in The Elements of Thought, published in 1878. However, it is in the work of Luria (1966a; 1966b; 1970; 1973b; 1976), and Das, Kirby & Jarman (1975; 1979) that we find the systematic development of this dichotomy.

Das et al, (1975) have noted that perhaps the most significant advantage of the processing model is its:

Proximity to behaviour or performance, describing modes of an individual's functioning in a test situation; it is easier and more meaningful to integrate the interplay between genetic endowments and the historical nature of an individual's experience with the characteristics of the task itself, as determinants of the processes used by an individual, rather than invoke the notion of abilities. (p.87)
The Kaufman Assessment Battery for Children (K-ABC) Mental Processing Scales are based on theories proposed by cerebral specialization researchers (Bogen, 1969; Nebes, 1974; and Gazzaniga, 1970) that suggest that the left hemisphere is lateralized for analytic, sequential, temporal, propositional processing, while the right hemisphere is lateralized for gestalt, holistic, spatial, appositional thought.

Research evidence in support of the two information processing styles that form the theoretical foundation of the K-ABC Intelligence scales comes from three sources: (a) studies conducted by experimental and cognitive psychologists, primarily in a laboratory setting; (b) factor analytic work done by Das and his colleagues in their pursuit of a partial validation of Luria's fronto-temporal versus occipital-parietal neuropsychological approach; and (c) experiments conducted primarily with split-brain patients or those with unilateral brain damage to explore the specialized functions of the left and right hemispheres. (Kaufman & Kaufman, 1983c, p. 26)

Luria (1966a; 1973b) proposed that mental activity depends upon the participation of the three functional units of the brain which were concerned with arousal, coding, and planning respectively. It is in the second functional or coding unit of the brain that information is obtained, processed, and stored. This unit is situated in the posterior regions of the neocortex, which includes the occipital, temporal, and parietal lobes.

As in all units, a hierarchical arrangement of cortical areas exist in this unit. The primary projection zones receive information and analyze it into elementary components. The secondary or projective association zones further organize the material and code it. The tertiary zones where information from various sources overlaps are essentially amodal. They are organized to form the basis of complex behaviour (Das et al., 1979, p. 39).
"In order for the human organism to grasp systems of relationships, it is necessary that the components of the systems be represented simultaneously" (Das et al., 1975, p. 189). Simultaneous processing is associated with tasks such as Raven's Progressive Matrices, Memory for Designs, Design Copying, and Wechsler's Picture Completion, Block Design, and Object Assembly subtests (Das et al., 1975; Naglieri, Kamphaus & Kaufman, 1980).

Sequential information processing involves the integration of individual stimuli into temporal or serial order. Each bit of information is related to the preceding one, either temporally or logically, and problems are solved in a linear rather than in a holistic manner with bits of information being processed in response to cues in a step-by-step manner (Gunnison, Kaufman & Kaufman, 1982). The important difference between sequential and simultaneous processing is that in sequential processing:

The system is not totally surveyable at any point in time. Rather, a system of cues consecutively activates the components. According to Luria, the most obvious example of the last variety of successive processing is human speech. The structure of grammar is such that the processing of syntactical components is dependent upon their sequential relationships within sentence structure. (Das et al., 1975, p. 89)

Sequential processing is associated with tasks such as the serial recall of words, free recall of words, and the WISC-R Digits Forward subtest. Das (1972) suggested that sequential information processing is required in associative learning, while simultaneous information processing is required in reasoning tasks.
The simultaneous and sequential model assumes that both modes of processing information are available to the individual at any given time. The decision as to which mode to use depends upon the individual's habitual mode of processing information as determined by social-cultural-genetic factors and the demands of the task itself (Das et al., 1975). Different cultural groups may have a proficiency in and a preference for one mode of information processing that is genetically and environmentally determined (Cummins, 1973; Cummins & Das, 1977).

Cultural Preferences for Information Processing

Factor analyses of different types of reasoning and memory tasks can be interpreted in terms of simultaneous and sequential information processing (Das et al., 1975). Simultaneous and sequential factors have emerged in the WISC-R for different groups of children, thereby giving support to the importance of the Luria-Das model for interpreting intellectual tasks (Naglieri, Kamphaus & Kaufman, 1983). Simultaneous, sequential, and speed factors have emerged in studies involving many different clinical and cultural groups, i.e. learning disabled and Native Indian children. While these different cultural and clinical groups employ similar strategies of processing information, differences may exist between groups in preference for and proficiency in a particular strategy (Cummins & Das, 1977). Normal and exceptional children may attack the same problem using different modes of information processing. Thus:

If we assume that normal children use the preferred or more efficient processing style, then it is conceivable that...children referred for learning problems are using inefficient strategies. These inefficient
modes of processing may be related to the exceptional childrens' known school-related problems; indeed the teaching of more appropriate problem-solving strategies will be a logical addition to remedial programs for children with learning problems. (Naglieri, Kamphaus & Kaufman, 1983, p. 31)

Das et al., (1975) suggest that "children from India lean on the successive mode for solving a task which invariably elicits simultaneous strategies in white children" (p. 94). Similarly, More (1984) indicates that Native Indian children use simultaneous processing on tasks that are usually processed by sequential means by Non-Native children. Conversely, some tasks may be processed by sequential means by Native Indian children and by simultaneous processing in Non-Native children (Das, 1973). Thus cultural or socio-economic group preferences may exist for the use of simultaneous or sequential synthesis as they may also exist for the use of reasoning and memory; in this way culture-specific information processing variability must be taken into account in the instructional setting and in the remediation of learning deficiencies. Das et al., (1979) have indicated that even within given cultural groups there can be differences in the preferred mode of processing. Naglieri et al., (1983) note that "tasks which are related to simultaneous processing for normal children may be more related to successive integration for exceptional children. That is, normal and exceptional children may employ simultaneous and successive processes differently in solving more complex tasks" (p. 32).

While some critics of the Das et al., (1975; 1979) model have equated simultaneous processing with reasoning ability and sequential processing with memory (Jarman, 1978), evidence that the simultaneous
and sequential factors are not hierarchical in the sense of Jensen's Level I/Level II abilities comes from loadings on the g factor noted by Kaufman, Kamphaus, Kaufman & Naglieri (1982). Level II or reasoning tasks typically have much higher g loadings than Level I tasks. However, the best measures of g for each age group and across the entire age span represented a proportional mixture of sequential and simultaneous tests. While Luria at no time indicated that the two types of information processing are hierarchically arranged, for some tasks one strategy of information processing may prove to be more efficient than the other (Das & Molloy, 1975).

**Linguistic Functioning**

The role of simultaneous and sequential processing in linguistic functioning may vary between groups and at different developmental levels. While both modes of processing are involved in linguistic functioning, sequential processes are clearly important because of the sequential nature of language and speech. Cummins & Das (1977) indicate that:

> Successive processing of linguistic input may be a prerequisite for deeper levels of semantic analysis involving simultaneous processes. Thus, in the reading process, successive processing may be important for the mastery of initial decoding skills but higher levels of fluent reading may depend more on simultaneous processing. In other words, among normal readers the conceptual-linguistic operations necessary for fluent reading may become independent of successive processing and consequently reading performance may relate more to simultaneous than to successive processing. However, among children who experience reading difficulties, initial deficits in successive processing may delay the differentiation of conceptual-linguistic
operations from more elementary forms of sequential linguistic processing. If this is the case, we would expect that simultaneous and successive processing would relate differently to reading performance in low-achieving and normal readers. (p.247)

Although both early and advanced reading are recognized by researchers as whole brain functions (Fox, 1979; Pirozzolo, 1978), there is evidence that sequential processing is relatively more important in decoding, and simultaneous processing is more important in higher-level comprehension (Gunnison et al., 1982; Cummins & Das, 1977; Kirby, 1980). However, specific linguistic skills and abilities appear to be lateralized to both the left and the right hemispheres and thus successful reading requires the interaction of both modes (Fox, 1979).

The left hemisphere has been shown to be more able to process information in an analytical, temporal, logical, or sequential fashion: language is an excellent tool for such processing (Kimura, 1961). Similarly, the right hemisphere would seem more able to deal with information in a holistic, simultaneous, or concrete fashion; and thus, nonverbal or visual-spatial modes are functionally linked to the right hemisphere.

To draw a verbal-nonverbal distinction between hemispheres, while convenient, may be a reductionist view of the process. Moreover, recent research in the area indicates one must closely examine the requirement of the individual task before assuming hemispheric differences in function. (Dean, 1984, p. 251)

To accept the notion of hemispheric differences in function is to suggest that information perceived in the right hemisphere is processed in gestalts rather than in detailed bits. This notion proposes that the
use of nonverbal/visual imagery facilitates right brain processing. This would also suggest that the left hemisphere perceives detail but lacks the ability for coherent organization. The right hemisphere would therefore be expected to process kinesthetic, auditory, and visual perceptions not related to language while the left hemisphere recognizes linguistic sounds and symbols more reliably (Fox, 1979).

Davis and Wada (1978) suggest that the left hemisphere is able to process temporal concepts while the right hemisphere processes spatial concepts. While the two hemispheres can be seen as being specialized for different cognitive functions, the continual use of one hemisphere can habituate the individual to either "left" or "right thinking" (Nebes, 1977).

Perhaps when people speculate about an inverse relationship between scholastic achievement and creativity, they are really talking about the effect of overtraining for verbal skills at the expense of nonverbal capacities. Many problems can be solved either by analysis or synthesis; but if people are taught to habitually examine only one approach, their ability to choose the most effective and efficient answer is diminished. (Nebes, 1977, p. 105)

One could infer from this that some children can have a right hemisphere "preference" and that such children would be handicapped in our school system with its curriculum emphasis on left hemisphere activities.

The process of reading can also be related to hemispheric preference. Symmes & Rapoport (1972) have provided evidence that among a specific subgroup of retarded readers (which was composed of 53 boys and 1
girl), there was a marked superiority (as compared to normal readers) for certain right hemisphere visual-perceptual skills and that these children were unable to use traditional methods of structural and phonic analysis to learn to read. However, these findings should be viewed in the context of the results of another study by Witelson (1976) which suggests that normal girls show evidence of bilateral representation of "spatial" processing until age 13, whereas boys perform in a manner consistent with right hemisphere specialization for spatial processing as early as age 6. Good readers, it seems, are able to unconsciously integrate the verbal (left hemisphere) and the visual (right hemisphere) aspects of reading (Fox, 1979).

Each half of the brain generates an outcome according to its own style of symbolic processing. The right side generates a non-verbal frameword for the whole text while the left side organizes the sequence of events, notes detail, and analyzes the verity of the author’s propositions. Readers who use only the right side of the brain are unable to respond traditionally to the teacher’s comprehension questions. Students who rely on the left hemisphere will remain reading students and never become readers. (Fox, 1989, p. 12)

Children obviously differ in their ability to learn when exposed to different types of input. Some children are more efficient learners when the input is visual and use purely visual means to abstract principles from images and pictures. Other children exhibit excellent auditory abilities and can usually remember details and information presented via oral lesson formats. A third group of children are efficient at recoding visual detail into internal verbal language. Another group of children appear to learn kinesthetically and are most proficient when allowed to write down information and to manipulate tactile objects (Kaulback, 1984).
Instructional materials will enhance and facilitate the child's ability to learn if they are matched to the child's perceptual strengths. This assumes that the child's strongest sensory modality is the most efficient one for processing information. The mismatch between instructional materials and processing strengths or learning style has been seen by Havighurst (1970) and Kleinfeld (1970) as a prime cause for school failure among Native Indian children. Kleinfeld (1970) claimed that Inuit children often possess unusual perceptual strengths which are seldom recognized or tapped within formal school programs. Kleinfeld further indicated that instructional materials designed to match the perceptual strengths of Inuit children would greatly facilitate their school learning. Havighurst (1970) also indicated that Native Indian children have unique perceptual abilities that require specifically matched instructional programs.

Simultaneous and Sequential Processing and Reading

Reading disability appears to be highly correlated with sequential processing tasks (Doehring, 1968). A similar correlation between sequential ordering difficulty and reading disability was found by Kinsbourne & Warrington (1966).

A considerable body of literature confirms the suggestion that poor sequential processing strategies have greatly limited reading achievement among groups of reading disabled and mentally retarded children, as well as children with lower socio-economic class backgrounds (Blackman, Bilsky, Burger & Mar, 1976; Blackman & Burger,
1972; Das, Leong & Williams, 1978; Das, Manos & Kanungo, 1975; Doehring, 1968; Kinsbourne & Warrington, 1966; and Leong, 1976). In this respect the normal child and the retarded child differ not only in achievement or in level of performance, but also in the very processes they use in cognitive tasks (Das, 1972).

Complex tasks may require a complex sequence of processes in correct juxtaposition. The strategy chosen is a function of the coded information available to the individual (i.e. his past experience), his habitual way of responding in certain situations (perhaps culturally determined), the processes he is able to use, and the outcome demands of the task (Das et al., 1979, p. 100).

Das, Manos & Kanungo (1975) indicated that 4th grade low SES group children predominantly used sequential processing as far as reading was concerned, whereas the high SES groups used a mixture of both processes. Das et al., (1975) concluded that both forms of processing are important, particularly in reading achievement, but that low SES children demonstrate a preference for the sequential mode. The relationship between the information processing dimensions and school achievement is undoubtedly very complex. However, it is reasonably apparent that if some children habitually process some types of information in their weaker mode, that they will meet with limited success.

Krywaniuk (1974) compared Native Indian children with Non-Native children and found the Native children to be significantly lower in WISC Verbal IQ than low achieving Non-Native children. However, Krywaniuk (1974) attributed this verbal deficit to the relative deficit of the Native children in sequential processing, to the extent to which verbal skills
are contingent upon sequential (and not so much on simultaneous processing) at an early age of their development. Reading in the early stages, it seems, is closely related to sequential processing. The poor verbal IQ and lack of success in reading of Native children may be a reflection of their ineffective use of sequential processing. Native children apparently do not choose sequential processing because it is not the habitual mode of information processing in their culture. If this relationship between sequential processing and the establishment of early reading skills is confirmed, it would be difficult to visualize how Native children would differ from any other children with reading difficulties.

If Native children are characterized by deficits in sequential processing, they may experience a lag in the differentiation of deeper levels of conceptual-linguistic abilities from more elementary or more surface forms of sequential-linguistic processing. Since the development of adequate reading skills depends upon semantically-based linguistic operations, this delayed differentiation may explain the significant relationships which have been observed between sequential processing and reading performance among Native Indian children. Studies relating simultaneous and sequential processing to reading suggest that, among reading disabled children, sequential processing accounts for more variance in reading scores than does simultaneous processing (Kaufman & Kamphaus, 1984).

The importance of sequential processing for early reading is consistent with early research that indicates that disabled readers are particularly weak in sequencing abilities and in tasks that depend on
sequential processing (Blackman & Burger, 1972; Das et al., 1975; Kaufman, N.L., 1980; and Rugel, 1974). According to Cummins & Das (1977), and Kirby (1980), decoding and other early reading tasks depend primarily on sequential processing, whereas fluent reading results from simultaneous processing and once normal readers master the "code" and thus possess the conceptual-linguistic skills for competent reading, future success in reading becomes independent of sequential processing. Naglieri (1984) indicates that "the PIAT subtests Reading Recognition, Reading Comprehension, and Spelling were significantly related to Sequential as opposed to simultaneous processing, suggesting that these reading and spelling tasks had strong sequential components for this sample" (p. 378). Cummins & Das (1980) reported that sequential processing is significantly related to WRAT Reading and Spelling as well as to WISC-R Verbal Comprehension.

Different subgroups of reading disabled children have been identified by several researchers. Satz (1976) identified a large subgroup of reading disabled children demonstrating a deficit or lag in auditory-temporal processing. These children usually have lower WISC Verbal than Performance IQ's and are often characterized by speech and language problems. The prevalence of language related problems in reading disability was demonstrated when 83% of Warrington's (1967) sample of reading disabled children performed more poorly on the Verbal scale of the WISC than on the Performance scale. Mattis, French & Rapin (1975) characterized reading disability as problems in language acquisition. "There is evidence that linguistic problems of this subgroup may stem from difficulties in successive processing related to
neurolinguistic factors associated with the dominant fronto-temporal lobe" (Cummins & Das, 1977, p. 250). The sequencing problems evidenced by Boder's (1971) dysphonetic dyslexics is suggestive of a deficit in sequential processing. The dyseidetic dyslexics in Boder's sample displayed difficulty visualizing letters within words, and had deficit patterns suggestive of poor simultaneous processing. However, 91% of the dyslexics in Boder's sample displayed deficits in sequential processing.

Both simultaneous and sequential processing can be identified in school children through cognitive measures as early as grade one (Das & Molloy, 1975), but when language research is considered, indications are that simultaneous synthesis is a more advanced form of cognitive activity. In fact, the two modes of processing are not of equivalent status developmentally, and a substantial body of data gathered by Jensen (1984) appears to indicate that sequential synthesis is potentially a less discriminating cognitive activity than is simultaneous synthesis (Kaufman & Kamphaus, 1984). Sequential processing appears to be uni-dimensional in nature (Kaufman, 1983) and all of the sequential processing subtests appear to be measures of memory span (Hall, 1984). Thus these short-term memory tasks may reflect too limited a sampling of a broader class of behaviour to allow for meaningful comparison with simultaneous processing (Das et al., 1979).

While both decoding and comprehension aspects of reading show higher correlations with sequential processing than with simultaneous processing for new readers (ages 5-7), simultaneous processing skills
seem to become more important for experienced readers as the two processes correlate about equally well with reading achievement for 8-12 1/2 year olds (Kaufman & Kamphaus, 1984). Thus simultaneous and successive processes are differentially important for different aspects of linguistic functioning (Cummins & Das, 1977; Cummins, 1973).

Several researchers have identified a visual-spatial group of reading disabled children. These children appear to have difficulty analyzing the visual-spatial aspects of written language (Mykebust, 1965; Tallal, 1976). Johnson & Myklebust (1964) found that 43% of the reading disabled children in their study had visual processing disturbances. Warrington (1967), however, reported a considerably lower percentage of visually dyslexic children. Doehring (1968) and Ingram (1960) indicated that the group of reading disabled children with visual processing difficulties was characterized by Performance IQ deficits on the WISC, reversals in letters and words, and by directional confusion and poor lateralization. In Luria's model, these children are clearly experiencing difficulties in simultaneous processing.

Satz (1976) indicates that simultaneous processing contributes to the development of early reading skills, particularly the perceptual operations which are used to obtain meaning from "surface structure," and the (spatial) ability to recognize letters or words as meaningful patterns or gestalts (Pirozzolo, 1978). If, according to Luria (1970; 1976b), simultaneous processing is necessary for the discovery of conceptual relationships between objects and events, then we would expect it to be involved in the more advanced stages of a skill such as
reading (and particularly with regard to comprehension).

The increasing importance of simultaneous processing in reading comprehension for more advanced readers - Reading/Understanding correlated .51 with simultaneous, and .46 with sequential, for ages 8-12 1/2 (Kaufman & Kamphaus, 1984) - is consistent with data reported by Cummins & Das (1977) in their study of third grade children. These authors found that simultaneous processing was more related to advanced reading comprehension skills than to sequential processing abilities. Das et al., (1979) indicated that for the average reader, reading achievement seems to be equally dependent upon both processes, and only on the simultaneous for the better reader. Bakker (1967) indicated that poor readers consistently have been found to have difficulty in the perception of sequences, and with cognitive tasks requiring sequential ability (Kaufman, 1979; Rugel, 1974).

McRae (1981) found a relative deficiency in simultaneous processing among children who scored high in decoding but low in comprehension on the PIAT. Thus while high levels of simultaneous and sequential processing are necessary, neither by itself are sufficient for high (reading) achievement; proficiency with both forms is necessary.

Because complex achievement tasks would depend on both forms of processing, high levels of achievement should only be attainable by individuals possessing high levels of both simultaneous and successive processing ability. Moderate levels of achievement, however, should be attainable by those possessing moderate levels of both or by those high in only one of the two modes of processing (Kirby & Das, 1977, p. 565)
Both forms of processing are therefore important to the successful manipulation of complex tasks like reading, but neither is necessary or sufficient for the other as the model is nonhierarchical.

While Leong (1976) would conclude that simultaneous and sequential processing are both necessary for reading competence, he would also claim that they do not have direct effect on reading achievement, but rather affect linguistic awareness and that this affects reading achievement (Leong & Haines, 1978). Thus "language awareness is a mental activity which interacts with other cognitive activities on which it depends and which it can modify in turn" (Leong, 1982, p. 19). This would suggest that the appropriate strategies, which are incorporated in the third block of Luria's model, as well as coding (the second block), are crucial to the adequate development of reading skills. This relationship may be developmental and interactive and change as a function of the child's maturational level and level of reading competence.

The poor reading abilities of many children may not be entirely attributable to cognitive deficits; failure to effectively apply intellectual skills to literacy-based academic tasks such as reading may be significantly related to skill deficits (Cummins & Das, 1980).

The nature of reading disabilities appears to be multidimensional but adequately encompassed within the simultaneous and sequential model. Leong (1976) compared reading disabled and control children in terms of their performance in dichotic listening as well as on simultaneous and sequential tasks. His results indicate that there is little difference in
factor structure for simultaneous and sequential processing for the two groups, but they are quite different in competence in the tasks in spite of being matched for non-verbal IQ. The poor readers may be using inefficient strategies for approaching the tasks - thus the deficiencies may not be in reading but in strategic behaviour (Das et al., 1979).

Doehring (1976) correctly points out that the acquisition of reading proficiency is not a unitary process but is instead a complex process that involves a number of component skills. Because the component skills are part of a process and are thus interdependent rather than independent, deficiencies in one or two skills can result in general deficiency in all reading skills.
The Information Processing Model and the K-ABC

Information processing was seen by Hunt (1980) as a framework that could accommodate other models of mental processes and strategies. This framework rested on three requirements: that the structure for the model would be the brain, that the operating processes would be neuropsychological, and that the knowledge base would always be provided by the experiences and education of the information processor. Such information processing models as presented in contemporary American psychological literature have either attempted to explain mental processes in terms of perception and short-term memory or have concerned themselves with the way in which problem-solving activities take place (Das, 1984a). In this way, the model provides the psychologist with an indication of the child's functional competence in relation to other children of his own age (and culture) while at the same time revealing the problem solving strategies used by the child.

While the K-ABC appears to offer a theoretically consistent battery of tests that provides information about children's cognitive processing beyond that provided by more traditional measures of intelligence, the direct neurological implications of the K-ABC remain to be investigated (Dean, 1984). "Portrayed as differences in cognitive processing, the successive-simultaneous scales of the K-ABC would seem to relate quite closely to the co-existing modes of thought attributed to left- and right-hemispheric differences" (Dean, 1984, p. 251).

The similarity between the lateralized functions of the brain and subtests for each mental processing scale of the K-ABC has been
reinforced by factor analytic studies published in the Interpretive Manual (Kaufman & Kaufman, 1983). These results are consistent with a considerable body of research that would suggest that the hemispheres of the human brain serve specialized functions (Dean, 1984). However, arguing from the position of cerebral lateralization theory, Kinsbourne (1982) stated that mental activities that "relate to action in the real world...make demands on the co-ordinated action of both sides of the brain" (p. 415).

Luria's position never isolated each process of cognitive information processing within a specific hemisphere of the brain. Luria tended to see the brain as being hierarchically organized to integrate information across hemispheres as well as from its lower or deeper centers. For this reason, dichotomy of function does not do justice to the wonderful hemispheric complexity of the brain. Luria would be concerned only with the way the hemispheres are able to organize or represent information rather than the type of information to be organized: thus process is the operational definition of the model and not content (Luria, 1970; 1973b).

Despite Luria's position, several cerebral specialization researchers have emphasized the content processed by each hemisphere, i.e. verbal content processed primarily by the left hemisphere, and visual-spatial content processed primarily by the right hemisphere (Sperry, 1968; Milner, 1971). Luria & Simernitskaya (1977), Levy-Agresti & Sperry (1968), Bogen (1969), and Levy & Trevarthen (1976) shifted research away from this verbal versus non-verbal content dichotomy. The shift was in the direction of analytic, sequential, serial, temporal processing
versus gestalt, holistic, unitary, non-temporal processing (Springer & Deutsch, 1981).

Das et al., (1975; 1979) suggested that successive processing was a product of the frontal-temporal areas of the brain and simultaneous processing a product of occipital-parietal regions: this view was consistent with Luria's (1966a; 1966b; 1973b) findings. However, other researchers in cerebral specialization have suggested that no proven relationship exists between brain localization and neurological correlates (Kinsbourne & Hiscock, 1977; 1978). Despite the uncertainty as to these neurological correlates, Kaufman & Kaufman (1983c) state that:

Evidence from neurologic, neuropsychological and cognitive studies, taken as a whole provides widespread support for an important processing dichotomy...it is the broad-based, multifaceted evidence from research and theory in diverse psychological disciplines that we consider to constitute the theoretical basis for the K-ABC intelligence scale. (p. 29)

The information processing model assumes that input is either presented to the receptors all at once (simultaneously) or in sequential fashion, then enters the sensory register.

Then information proceeds to the central processing unit, which is responsible for sorting information and synthesizing it according to a goal or a purpose. The central processing unit, thus, is conceived to have two major functions. One is the analysis and synthesis of information; the other is planning and decision making based on coded information. The third unit of the model is concerned with output, which could be simultaneous, as in recognition of old from new items in a memory experiment, or successive if recall is required. (Das, 1984b, p. 20)
Either simultaneous or sequential information processing may be evident before the other and exhibit a distinct pattern of development that is not shared by the other. Das (1984a) contended that the question as to which form of processing develops earlier is as yet unresolved. However, some light is shed on this issue by the development of paradigmatic and syntagmatic association as Luria (1966b; 1973b) claimed that syntagmatic associations developed before paradigmatic associations. That paradigmatic association is a variation of simultaneous coding was considered to be a reasonable assumption by Das et al., (1979). For this reason it may be concluded that based on this specific linguistic function, sequential processes are operationalized earlier than simultaneous processes. This finding would also lend further support to the relationship between sequential processing and the early stages of reading (decoding) development.

There is some evidence in the recent research literature that both the K-ABC simultaneous and sequential tasks are not pure measures of those processes and for this reason the K-ABC may not enable us to explain why children perform as they do. A child's performance on simultaneous or sequential tasks may be largely dependent upon cognitive structures, strategies and planning functions that are not adequately operationalized or encompassed by the K-ABC (Goetz & Hall, 1984).

The lack of conclusive evidence regarding normal patterns of brain development prevents us from effectively evaluating the K-ABC processing dichotomy. Any emphasis on how a child processes information must take into account his/her problem solving strategies.
Despite the value of a processing model in its attempt to measure individual differences in cognitive behaviour, developmental differences in cerebral functioning across different age groups of children may be reflected in considerable variability in subtest performance.

Understanding how a child's brain constructs internal representations of the real world via experiences through development of cognitive information processing strategies involves detailed knowledge. Several aspects to consider are as follows: neurodevelopment; cerebral organization; acculturation in different cultures; cognitive mapping; sensory processing; memory storage capabilities; symbolic (abstract) representation; and use of language. These are the component parts in any attempt towards understanding of the development that takes place in a child's thinking (Majovski, 1984, p. 262).
The Kaufman Assessment Battery for Children (K-ABC)

Perhaps the primary goal in the development of the Kaufman Assessment Battery for Children (K-ABC) was to create a test that would assess intelligence from a strong, defensible theoretical and research base. The foundation for the processing model was derived mainly from the Kaufmans' evaluation and interpretation of research and theories in clinical neuropsychology (particularly Luria, 1966a; 1966b), cerebral specialization (Bogen, 1969; and Sperry, 1968), and cognitive psychology (Neisser, 1967). For this reason the K-ABC has been described as a major departure from previous measures of intellectual ability in that it represents a contemporary synthesis of information processing and psychometric evaluation (Goetz & Hall, 1984).

Theoretical Support for the K-ABC. The theory of intelligence underlying the K-ABC involves two major dichotomies: mental processing versus achievement, and simultaneous versus sequential processing. By separating mental processing from achievement, the Kaufmans intended to "separate acquired factual knowledge from the ability to solve unfamiliar problems" (Kaufman & Kaufman, 1983c, p. 5). The distinction between mental processing and achievement corresponds to the distinction between fluid and crystallized intelligence or between a "child's current level of intellectual functioning" (Kaufman & Kaufman, 1983c, p. 25) and "factual knowledge and skills acquired in a school setting or through alertness to the environment" (Kaufman & Kaufman, 1983c, p. 33). Thus the K-ABC is designed primarily to measure fluid ability as the basis for estimating intellectual potential. Tests of fluid ability are:
Culture fair perceptual and performance tests of judgement and reasoning that have been considered relatively culture-free. They involve solutions to tests of classifications, analogies, matrices, topology, and problems that do not involve much educational acquisition. (Cattell, 1968, p. 58)

However, the Sequential Processing Scale in the K-ABC has limitations as a test of fluid intelligence. In examining the three Sequential subtests, Bracken (1985) indicates that:

Not one of the three subtests measures the skills and abilities cited by Cattell as being associated with fluid intelligence (reasoning, judgement, analogies, etc). While associative memory is part of fluid intelligence, it is not the only element worthy of measurement. The Simultaneous Scale appears to coincide with Cattell's description much more closely than does the Sequential Scale, yet even on the Simultaneous Scale two of the seven subtests are primarily measures of short-term memory, leaving five subtests as measures of nonmemory related fluid intelligence. (p. 8)

This separation was probably made in order to control such environmental variables as SES, cultural background, educational achievement, and native language that could potentially negatively bias test results, thereby limiting the amount of intellectual potential predicted for a child (Obrzut, Obrzut & Shaw, 1984).

Cattell (1963;1968) equated fluid intelligence with culture fair measures, crystallized intelligence with general cognitive measures, and achievement with scholastic achievement measures. According to Cattell, achievement is a product of time, interest, memory, fluid intelligence, and crystallized intelligence (Bracken, 1985).

While the K-ABC Mental Processing Scales were intended to measure
fluid intelligence, validity studies reported in the Interpretive Manual (Kaufman & Kaufman, 1983c) and other independent studies (Naglieri & Haddad, 1984; Murray & Bracken, 1984) appear to indicate that the Mental Processing Composite correlates as well or higher than traditional intelligence tests with established measures of achievement. This would suggest that the Mental Processing Scales are as effectively related to achievement as other traditional measures of intelligence.

The Mental Processing subtests were intended to measure cognitive processes and strategies; the Achievement subtests would measure acquired knowledge. However, performance on the Mental Processing subtests is not totally free of the influence of previous learning or acquired knowledge. The attempt to design an intelligence test that would be free of the effects of previous learning may be self-defeating as it may not be entirely possible to exclude these measures of crystallized ability from the pool of items measuring general ability because they reflect long-term memory, and in some cases, the ability to apply previous learning (Obrzut et al., 1984). Similarly, a child's response to an achievement item inevitably involves the mental processing of information contained in the item. In this way it is difficult to partial out the influence of experience on information processing.

Anastasi (1983), in the 9th edition of the Mental Measurements Yearbook, indicates that information processing skills are impacted by a child's experiential background. Chi (1978; 1981) has argued that developmental differences in performance on memory tasks are largely
due to knowledge structures acquired and refined through experience. The ready availability of these knowledge structures may represent the difference between average and gifted individuals (Jackson & Butterfield, in press).

While the Kaufmans have attempted to control the influence of acquired knowledge on the K-ABC Mental Processing subtests by using stimuli representing common, familiar objects, children obviously differ in their exposure to the subtest materials, i.e. the foam Triangles or the geometric forms of the Matrix Analogies subtest. Thus prior knowledge and experience may be just as important as actual mental processing skills.

The simultaneous versus sequential dichotomy allows us to describe the way in which stimuli are manipulated: either in holistic units or feature-by-feature respectively. More specifically, simultaneous processing refers to the child’s cognitive ability to integrate or synthesize information simultaneously: this involves spatial, analogic, or organizational abilities (Kaufman & Kaufman, 1983c), as well as problem solving via visual imagery.

In sequential processing, each bit of information is related to the previous bit via linear or temporal relationships thus creating a type of serial interdependence (Kaufman & Kaufman, 1983c). In both forms of processing, the sensory modality by which the information is received is secondary to the process of mental synthesis. A number of researchers have proposed similar dichotomies. Some of these researchers have
indicated that the convergence of several theories lends support to the
dichotomous view of intelligence involving both the sequential and
simultaneous processing of information (Kaufman, Kaufman, Kamphaus, &
Naglieri, 1982). Simultaneous and sequential information processing are
constantly interacting:

Which mode of information processing takes the lead role can change
according to the demands of the problem or, as in the case of some
individuals, persist across problem type (i.e. forming what Das et al,
1979, refer to as habitual modes of information processing.) In
most cases, one method is clearly superior to another. It is the
latter case that makes the K-ABC a viable tool - the two scales are
primarily not exclusively sequential or simultaneous processing
measures. Pure scales do not exist just as pure processing does not
exist (Kamphaus & Reynolds, 1984, p. 215).

However, not all researchers agree with the simultaneous and
sequential dichotomy. Simon & Newell (1971) claimed that all human
information processing is sequential, and Anderson (1976) argued that
the simultaneous and sequential controversy is empirically unresolvable.
These theorists have not considered simultaneous or sequential
processing to be preferred modes of processing characteristic of and
varying between individuals (as is implied in the K-ABC). Kyllomen,
Lohinan & Snow (1984) claim that an individual may change strategies
with practice on a given spatial task or in response to specific or unique
item characteristics, and that an individual can be trained to change
strategies for a given task. Thus individual differences in information
processing are seen as differences in strategies that are subject to
change through experience rather than differences in preferred
information processing styles. Specific tasks are also amenable to
simultaneous or sequential processing strategies, and not just to one
favoured type of processing as assumed by the K-ABC.

Goetz & Hall (1984) maintain that for the most part, theoretical discussions about information processing have moved beyond the simultaneous and sequential debate. Current analyses have tended to focus on the order in which a sequence of events occurs and whether the processes involved are exhaustive or self-terminating (Goldman & Pellegrino, 1984), or on the development of automaticity (Fisk & Schneider, 1984; Schneider & Fisk, 1984).

Validity of the K-ABC. Construct validity is generally considered to be the most important type of validity for a test, and is sometimes considered to be the only type to warrant the label "validity" (Messick, 1980). Factor analysis is one of the ways of demonstrating the construct validity of a multiscale instrument (Anastasi, 1982). It is important that any new test be able to demonstrate construct validity but this:

is especially vital for the K-ABC because its measure of intelligence is theory based: in that sense, factor analysis of this new test battery permits evaluation of the obtained factors from the vantage point of the theoretical constructs that underlie the K-ABC's Mental Processing (intelligence) scales. (Kaufman & Kamphaus, 1984, p. 623)

Kaufman & Kamphaus (1984) examined the construct validity of the Sequential Processing, Simultaneous Processing, and Achievement Scales of the K-ABC using a representative national sample stratified by sex, race, SES, geographic region, and community size.
Analyses of the ten Mental Processing subtests for eleven age groups produced two significant factors per age with clear-cut Sequential and Simultaneous dimensions emerging for each group. Furthermore, analyses of all 16 subtests produced three factors corresponding to the three K-ABC scales for ages four and above. In general, the factor analyses provided strong support for the K-ABC. (Kaufman & Kamphaus, 1984, p. 623)

There has been considerable factor analytic support for the existence of the simultaneous and sequential dichotomy that forms the foundation of the K-ABC (Kaufman & Kamphaus, 1984). Factor analysis of the K-ABC standardization data generally offers support for the validity of the two Mental Processing scales, but analyses that included the Achievement tests have generally been considerably less supportive (Kaufman & Kamphaus, 1984; Kaufman et al., 1982; Keith, 1985).

Willson, Reynolds, Chatman & Kaufman (1983) indicate that confirmatory factor analysis does offer support for all three K-ABC dimensions, including Achievement, across the entire 2 1/2 to 12 1/2 year range.

The factor analysis of the Mental Processing subtests alone, and of all subtests combined, offer clearcut support for the existance of the Sequential and Simultaneous constructs across the entire 2 1/2 to 12 1/2 year age range and, hence, for the theory underlying the K-ABC measure of intellectual functioning. (Kaufman & Kamphaus, 1984, p. 627)

Results of the factor analysis of the K-ABC as reported in the Interpretive Manual (Kaufman & Kaufman, 1983c) reveals two distinct but not pure factors assumed by the Kaufmans to be simultaneous and sequential factors. A previous study by Naglieri, Kaufman & Kaufman
involving a two factor solution revealed clear-cut simultaneous and sequential factors. Naglieri et al., (1981) indicated that:

The results of this study give strong support to the existence of successive and simultaneous processing dimensions in normal school-aged children, and can be interpreted as an independent cross-validation of the model proposed by Das and his colleagues. (p. 269)

Confirmatory factor analysis, judged by the Kaufmans (Kaufman & Kaufman, 1983c) to be more appropriate than the principal components method, demonstrated the presence of three discrete factors for all ages, including the youngest children (Wilson, Reynolds, Chatman & Kaufman, 1983). Other confirmatory analyses involving two-factor solutions of the K-ABC Mental Processing Tests (Keith, 1985; Willson et al., 1983) have "generally provided a fairly good fit to the standardization data, while three-factor solutions of both mental processing and achievement test results have generally produced only moderate to poor fits" (Keith & Dunbar, 1984, p. 367). Keith (1985) has suggested that the K-ABC might be measuring primarily verbal memory, non-verbal reasoning, and verbal reasoning (in addition to reading), rather than sequential and simultaneous processing and achievement, respectively.

Obrzut et al., (1984) reported a high correlation between the Mental Processing Composite and the WISC-R Full Scale IQ (r=.80), and suggested that this relationship "offers evidence of the construct validity in the measurement of intellectual functioning in the sample of special population children" (p. 419). However, it is notable that while the K-ABC diagnosed the learning disabled children in the Obrzut et al.,
Naglieri & Haddad (1984) also reported that the K-ABC Mental Processing Composite correlated as well or better than the WISC-R Full Scale IQ with the PIAT Total Test score thus providing concurrent validity support for the K-ABC. Naglieri & Haddad (1984) concluded that their findings provided evidence of the construct validity of the K-ABC as a measure of ability and achievement for learning disabled children.

There is evidence that the Simultaneous Processing Scale measures a "spatial ability" factor reported in other measures of intelligence, and for this reason may be particularly useful in identifying the information processing strengths of special population or cultural minority children. Obrzut et al., (1984) indicated that:

The Simultaneous Processing Scale, designed to assess holistic processing, was strongly related to the WISC-R Performance IQ and Full Scale IQ, thus offering evidence of construct validity in the non-verbal and performance areas of intelligence. It appears that the Sequential Processing Scale is measuring a new construct (analytic, temporal sequencing) in intelligence assessment. This may have particular utility in the area of remediation with special population children. (p. 422)

Thus the Simultaneous and Sequential Processing Scales might be interpreted as measuring non-verbal reasoning or simultaneous processing and verbal memory or sequential processing (Keith & Dunbar, 1984).

In making comparisons between different cultural groups, it is important to know if a test is able to predict equally well for the
various groups involved. Even if a test produces consistent mean score differences between different cultural groups, it can still predict future achievement equally well for these groups. Thus mean score discrepancies should not be viewed as an indication of test bias or fairness (Anastasi, 1976; Cleary, Humphreys, Kendrick & Wessman, 1975; Reynolds, 1982). The differences in mean scores can be assumed to reflect actual differences in abilities or attainments between cultural groups (Cleary et al., 1975; Jensen, 1980).

This issue of the differential (cultural) validity of the K-ABC has not yet been resolved. If the K-ABC is to be a useful tool in assessment and remedial procedures, it must demonstrate that it has predictive validity, i.e. that it can predict the future achievement of Native and non-Native children equally effectively. Further studies using the K-ABC to predict achievement over a 1-2 year period for Native and non-Native children are needed to establish this predictive validity.

Kaufman (1983) indicates that the median predictive validity coefficients for the Mental Processing Composite Scale is .58 for 6 studies. Concurrent correlations of the Mental Processing Composite with reading achievement are: .63 with the Woodcock Passage Comprehension for a large sample of 592 children aged 6 - 12 1/2 years; .55 with the WRAT Reading (N=114) and Stanford Diagnostic Reading Test (N=63); and .52 with measures of reading in various group achievement batteries (N=369).

Kaufman (1984) further indicates that predictive validity
coefficients for the K-ABC:

Are of the same general magnitude as the values found for the WPPSI and WISC-R, despite the fact that the K-ABC excludes from the Mental Processing Composite tests resembling Wechsler's Vocabulary, Information, and Arithmetic - measures characterized as acquired knowledge by Bannatyne (1971). (p. 411)

Thus both sequential and simultaneous processing appear to correlate equally well with various measures of reading, with composite scores of various achievement batteries, and with verbal intelligence (Kaufman & Kaufman, 1983c). The average of all coefficients reported in Table 1 of the Interpretive Manual (Kaufman & Kaufman, 1983c, Chapter 4) was .453 for Sequential Processing and .475 for Simultaneous Processing. However, the average coefficient for the Mental Processing Composite was substantially higher (.550) than the coefficient of either process alone indicating that "the amount of information provided by the relatively brief Sequential Processing Scale adds significantly to the information yielded by the longer Simultaneous Processing Scale regarding prediction of achievement criteria" (Kaufman, 1983, p. 215). The average reliability coefficients as reported in the Interpretive Manual (Kaufman & Kaufman, 1983c) for ages 5 - 12 1/2 are .89 and .93 for the Sequential and Simultaneous processing scales respectively.

Additional data on the K-ABC Mental Processing Composite suggest that it is a good measure of school achievement, and that the short-term memory tasks, with the exception of Number Recall, require the use of mediation and planning and are not simply rote learning tasks (Kaufman, 1984).
The K-ABC and Minority Group Differences. The relationship between SES and intellectual level is well established in the literature; the higher the SES the higher the mean IQ. This relationship between SES and IQ would also apply to certain cultural groups that are predominantly of low SES, i.e. Native Indians. The Kaufmans made a deliberate attempt to reduce SES differences on the K-ABC: the verbal requirements that may reflect culturally-oriented linguistic differences were reduced; more complex intellectual behaviours were reduced (i.e. Digits Backward); the social comprehension/reasoning components of the test were limited; disproportionately high numbers of upper SES minorities and undersampling of low SES minorities were included; and the reduced effects of the minority group cumulative deficit (Tyler, 1965) due to the ages for which the K-ABC is appropriate. The net result of this process is to reduce the cultural minority-white:

Mental Processing Composite differences in the standardization sample, it increases the SES level of the entire standardization sample and produces a higher SES normative sample to which low SES minority children in the typical school setting will be compared. The higher socioeconomic standard will likely result in lower scores from low SES minority children than expected, and lower than if a more accurate socioeconomic sample were drawn. (Bracken, 1985, p. 24).

While these modifications may have reduced mean score differences on the K-ABC between Native Indians and Non-Natives, they may have done so at the expense of reduced differential predictive validity for the two cultural groups.
The K-ABC and Reading. There are three preliminary studies reported in the K-ABC to suggest that reading disabled children who are taught by experimental methods based on their preferred processing style improve more in reading (especially comprehension) than control groups remediated by conventional methods or given no special treatment (Kaufman & Kaufman, 1983c, Chapter 7). However, these studies use rather small sample sizes (8, 14, and 16 children), show modest effects, and are restricted in generalizability (Kaufman & Kaufman, 1983c, Interpretive Manual). The Interpretive Manual also indicates that sequential and simultaneous processing correlated equally well with a number of measures of reading proficiency.

A number of researchers have indicated that reading disorders in children appear to result from a deficit in temporal sequencing (Allen, 1975; Bakker, 1967, 1972; Corkin, 1974; Obrzut, 1979; and Senf, 1969). A basic assumption in reading is that sequential processes are required before simultaneous processes: the ordering of letters is necessary for the child to read words; and the decoding of words must precede comprehension. However, this does not mean that simultaneous processing is at a higher level than sequential processing.

One may think that comprehension is much more complex than decoding, hence simultaneous processing is higher. But the perception of lexical ambiguity is related to simultaneous processing, whereas the perception of surface- and deep-structure ambiguity seems to be related to successive processing. (Das et al., 1979, p. 127)

Kaufman & Kamphaus (1984) indicated that both reading decoding and comprehension showed a higher correlation with sequential processing
than with simultaneous processing for new readers (ages 5-7), but that simultaneous processing skills appear to become more important for more experienced readers (ages 8-12 1/2) when the two processes appear to correlate equally well with reading. Cummins & Das (1977) also reported that simultaneous processing was more highly correlated with advanced reading comprehension skills than sequential processing (with third grade children). Cummins & Das concluded that although simultaneous and sequential processing are necessary for reading comprehension, simultaneous processing may have a stronger relationship to more advanced levels of reading comprehension.

This finding of the importance of sequential processing for the development of early reading skills is consistent with a considerable body of research which indicates that children with deficiencies in reading tend to be weak in sequencing abilities and have difficulty with tasks that require sequential processing (Blackman & Burger, 1972; Das et al., 1975; Kaufman, N.L., 1980; Rugel, 1974). These findings, however, are disputed by researchers who contend that disabled readers are deficient in both simultaneous and sequential processing. Leong (1976) indicated that children with reading deficiencies exhibit factor structures for simultaneous and sequential processing very similar to those of control children, but that the disabled readers scored consistently lower on both simultaneous and sequential processing tasks. Das et al., (1979) suggested that the difficulty resided in the strategies necessary for reading and not in reading itself. Das et al (1979) have called for further research to determine the extent to which one type of coding is more necessary than another for various aspects of reading.
These authors also stressed the need to investigate the relationship between competence and the three components of the Luria and Das models (planning, simultaneous processing, and sequential processing).

Kaufman (1984) indicates that factor scores and standard scores for sequential processing correlated as highly with reading skills (both within the K-ABC and external to the battery) as simultaneous processing scores (Kaufman, 1983; Kaufman & Kamphaus, 1984; Kaufman, 1984).

These coefficients range from the mid .40's to the mid .50's, values that are higher than those found for the WISC-R Performance IQ (mid .30's to mid .40's), though less than the values in the low to mid .60's identified for the achievement laden WISC-R Verbal IQ. (Sattler, 1982, p. 150)

The K-ABC and Educational Intervention. Das (1984c) indicated that the K-ABC was perhaps the first standardized battery of intelligence tests that attempted to measure processes and therefore allowed for the suggestion of suitable remedial procedures. Naglieri & Haddad (1984) confirmed Das' opinion in suggesting that "because the K-ABC measures intelligence from a process rather than a content perspective, it has greater potential for leading to effective remedial plans than current measures" (p. 50). In this way assessing a child's performance at the level of cognitive processes and specific information processing skills should enable us to determine where the child is experiencing difficulty. This individualized assessment should help us make more comprehensive diagnostic use of test data (Estes, 1974; Sternberg, 1979). This, of
course, was the Kaufmans' intention; that the K-ABC information processing model would facilitate the development of intervention/instructional programs matched to the needs of the individual child.

The unique definition of intelligence proposed by the K-ABC defines "an individual's style of solving problems and processing information; this definition, which also stresses level of skill in each style of information processing, has a strong theoretical foundation in the domains of both neuropsychology and cognitive psychology" (Kaufman & Kaufman, 1983c, p. 2).

Intelligence can be viewed as individual differences in cognitive acts (Hunt, 1983). These individual differences, as measured by the Mental Processing Scales, "measure the child's ability to solve problems sequentially and simultaneously with emphasis on the process used to produce correct solutions, not on the specific content of items" (Kaufman & Kaufman, 1983b, p. 1). Thus "mental behaviour (is) explained by identifying the processes involved in problem solving, rather than producing abstract descriptions of the outcome of thinking" (Hunt, 1983).

It is logical to assume that understanding a child's preferred learning or problem solving style would enable us to design effective instructional procedures for specific academic skills. The Kaufmans (1983c) present numerous suggestions for teaching specific reading, spelling, and mathematics skills by methods that are primarily sequential, primarily simultaneous, or emphasize a combination of both processes.
"The direct teaching of academic areas by methods that are geared to the child's more efficient mode of processing information, is desirable" (Kaufman & Kaufman, 1983c, p. 235). This means that once a child's preferred mode of processing (information) or processing strength has been identified, instructional materials compatible with this mode of processing are presented. In this way the K-ABC is used to determine a child's information processing strength with the assumption that the outcomes of matched instructional activities will generalize to a variety of academic situations. Thus the K-ABC does not approach remediation from an ability training model as it does not attempt to remediate underlying cognitive deficits. Instead, the K-ABC suggests teaching the child with instructional materials optimally related to the child's measured information processing strengths. The K-ABC clearly focuses on instruction directed toward a child's area of academic deficit but with materials that allow the child to exploit his/her preference for a particular style of information processing (Kamphaus & Reynolds, 1984).

Empirical support for this assumption comes from unpublished studies by Gunnison, Town & Masunaga, and by Gunnison & Moffett (both in Kaufman & Kaufman, 1983c). However, no empirical support is offered for the individual strategies and there is no data in the Interpretive Manual to indicate the superiority of these instructional methods over other instructional reading models for children with various K-ABC profiles (Salvia & Hritcko, 1984).

While it would be desirable that we be able to demonstrate that
processing abilities predict gains in knowledge following systematic instruction, Goetz & Hall (1984) express concern about the effectiveness of the K-ABC intervention model because:

Information provided by the K-ABC is not sufficient to permit adequate understanding of the causes of an individual's performance on the tasks that comprise the instrument, or to illuminate the nature of the individual's cognitive capabilities in other contexts. (p. 286)

This concern had previously been established by Torgesen & Houck (1980): that the causal link between processing deficits on diagnostic tests and learning problems in school has not yet been established. The fact that a variable is related to achievement and learning may not be sufficient justification for its use in planning instructional activities. It is obvious that further research is needed before relationships between information processing variables and groups of children can be systematically and confidently used to make accurate instructional decisions for individual children. Nevertheless, Hartlage & Lucas (1973) have provided some interesting data with a grade one sample: they found modest multiple correlations between processing variables (i.e. visual sequencing, visual/aural space, auditory sequencing, and letter identification) and scores on the WRAT. While this evidence would suggest that matching reading instruction to K-ABC processing variables is justifiable with grade one children, firm research evidence for the same instructional interventions is lacking for other grade levels. It is conceivable that the same tasks might make different processing demands depending upon the developmental level of the child. A developmental study that matches K-ABC information processing skills
with reading development across an age range (i.e. 7-12) is needed; this study addresses itself to that need. Das and Molloy (1975) conclude:

It seems reasonable to expect that if teaching methods are modified to capitalize on the simultaneous factor, children showing a preference for this mode of thought would learn more effectively. Conversely, children favouring a successive mode might profit more from a sequential approach. (p. 219)

Kaufman & Kaufman (1983c) reconfirm this conclusion in the K-ABC Interpretive Manual:

We strongly feel that remediation based on the K-ABC should follow the aptitude-treatment-interaction (ATI) approach...namely, the direct teaching of academic areas by methods that are geared to the child's most efficient mode of processing information. (p. 235)

The British Columbia Quick Individual Educational Test: B.C. QUIET.

The B.C. QUIET Achievement Test was designed to Measure achievement in three general areas: reading, spelling, and arithmetic. Subtest content has been chosen from prescribed or authorized materials and closely parallels the B.C. curricula thus content validity is high for B.C. children. The two reading subtests chosen from the B.C. QUIET are Word Identification and Passage Comprehension.

The Word Identification subtest provides convenient evaluation of a subject's sight vocabulary and decoding skills. Items were randomly selected from levels 2 to 14 of the prescribed Ginn 720 series for grades 1-7. This series was selected because it is one of two basal reading
series prescribed by the British Columbia Ministry of Education and is used by most of the school districts in the Province. Items for nominally higher grade levels were randomly selected from authorized literature texts used in the secondary schools (6 items from each of grades 7-12) and from an encyclopedia for items above grade 12.

The Passage Comprehension subtest items were also selected from words used in the Ginn 720 series and from prescribed or authorized texts used in grades 8 through 12. "Items were designed with a modified cloze technique to assess pupils' understanding of what they were reading and were intended to represent the difficulty levels of the texts" (Wormeli, 1983, p. 6). The Passage Comprehension subtest was designed to measure a child's ability to understand the meaning(s) of words grouped into phrases, sentences and paragraphs. An oral modified cloze item format is used to indicate ability to comprehend contextual clues essential to the meaning of a passage (Wormeli, 1983). The range of nominal item difficulty extends from kindergarten or grade one to approximately grade 12 in order to provide a sufficient range to reduce the possibility of artificially high basals and low ceilings (Wormeli, 1983).
A four step developmental sequence was undertaken before norming/validation: 1) a first tryout; 2) a revision of norming/validation; 3) a second tryout; and 4) a second revision.

The two formal tryouts were conducted in 5 B.C. lower mainland school districts: 1) 173 students stratified by grade level randomly selected from twelve participating schools (students assessed as mentally retarded, emotionally disturbed, physically unable to respond to the test, or with a poor understanding of English were excluded); and 2) 90 students in twenty one schools in four B.C. lower mainland school districts in grades 2, 4 and 6 were randomly selected. No attempt was made to control for SES or ethnicity. (Mentally retarded, emotionally disturbed, physically handicapped and English language handicapped students were excluded.)

The population for the norming phase...consisted of all children enrolled in public and private B.C. schools in grades 1-7. The population was restricted to exclude children who were formally diagnosed as mentally retarded, emotionally disturbed or who had a physical handicap that would have made it difficult for them to take a paper and pencil test or who had not mastered English sufficiently well to understand test instructions. A random sample of 1750 children, divided equally by grade and sex, was selected from this population. This allowed for a non-participation rate of 20%, yielding desired sample sizes of 200 at each grade level, and total sample size of 1400.

A two-stage deeply stratified design was employed. At the first stage schools, stratified by geographic region, rural-urban and distribution size, were selected. At the second stage pupils, stratified by grade and sex, were chosen. Proportional sampling was used at Stage I: simple random sampling was used at Stage II (Wormeli, 1983, p. 18).
Internal consistency reliabilities as reported in the B.C. QUIET manual indicate that the lowest reliability estimate is .68 for the Arithmetic subtest at grade 1; Passage Comprehension reliability is .76 at grade 5; Arithmetic .78 at grade 5; and Passage Comprehension .78 at grade 6. All other subtest reliabilities are in the .80's or .90's which are acceptable levels for an achievement test (Anastasi, 1976). The Word Identification subtest has the highest reliability figures at every grade level.

Content validity of the B.C. QUIET is assumed to be high as all test items were chosen from B.C. Ministry of Education curricula and materials commonly in use throughout the Province.

The empirical validity of the B.C. QUIET was investigated by selecting separate samples of 90 pupils in grades 3 and 6 who were enrolled in Learning Assistance or other remedial programmes. The results of the discriminant function comparison indicated that the remedial group scored significantly below the non-remedial group on the Word Identification and Passage Comprehension subtests. For the grade three group, the Word Identification subtest was able to correctly classify 84 of the 86 remedial students, and 37 of the 43 non-remedial students. The overall correct classification rate was 93.8%. For the grade 6 group, 85 of 86 remedial students and 38 of 43 non-remedial students were correctly classified. The overall correct classification rate was 95.4%. These investigations, while with limited samples, suggest an acceptable level of empirical validity.

Hardman & Oldridge (1985) reported high correlations between the
B.C. QUIET and the Woodcock-Johnson: Achievement Battery (.76 to .87). The authors concluded that "the B.C. QUIET has satisfactory concurrent validity with the Woodcock-Johnson: Part Two" (p. 37).

The Grip Strength Test

Every child in the study was administered the Grip Strength Test as a measure of neurological maturation. Grip Strength is an established subtest in the Reitan-Knove Sensory-Perceptual Examination, which is part of the Halstead Neuropsychological Test Battery for Children (Selz, 1981). Normative (Canadian) hand grip strength data for children ages 6-12 are available (Spreen & Gaddes, 1969). The authors suggested that this data would be useful for indicating the presence of neurological dysfunction.

Gaddes (1980) indicates that in a study of 154 learning disabled children with no clear neurological signs, "most of these children performed at a level below average on most of the sensorimotor tests (which included grip strength)...in the same way as brain damaged children do" (p. 163). Gaddes indicated that the Esthesiometer Test and the Dynamometer Grip Strength Test were failed by the greatest number of learning disabled children. He suggested that these tests should be considered sensitive indicators of central nervous system damage or dysfunction and are therefore reliable correlates of learning disorders.

Clinical experience also indicates that traumatically brain damaged adults do poorly on the Grip Strength Test regardless of their muscular development (Gaddes, 1980). O'Donnell (1983) compared left-right
asymmetries in sensorimotor abilities (e.g. grip strength of the Halstead-Reitan Battery) using groups of 30 normal, 60 learning disabled, and 20 brain damaged adults ages 17-29. The normal and learning disabled groups had significantly fewer asymmetries than the brain damaged group. This would suggest that learning disabilities involve cognitive but not sensorimotor deficiencies (Reitan, undated). These results support the idea of an association between neurobehavioural deficits and learning disabilities for this age group.

While there is at present no established relationship between grip strength and reading, the instructional process in teaching reading involves an assumption that the child is neurologically ready to read. Any test that measures psychoneurological maturation should demonstrate a developmental interaction with the process of reading. Because thalmic connections are involved in language in an integrating function (Penfield & Roberts, 1959), it would seem reasonable to assume that immaturity or developmental lag in these thalmic connections and/or brainstem efficiency would delay the development of reading skills (Gaddes, 1980).

Gibson (1965) produced a developmental model for the acquisition of reading skills. The child passed through stages where he/she: 1) learned oral language during the preschool years, 2) learned to differentiate visually graphic symbols, 3) learned to decode letters to sounds, and 4) learned to combine letters to produce words and words to produce phrases or sentences. Gibson (1965) noted that the visual discrimination of letter forms improves with age with some types of visual
discriminations developing more rapidly than others. Satz and his colleagues (Satz & Sparrow, 1970; Satz, Taylor, Friel & Fletcher, 1978) expanded Gibson's findings and proposed a theory of neurological maturational lag to account for cases of specific developmental dyslexia. This theoretical position presumes that reading disabilities are a reflection of a lag in cerebral maturation which in turn differentially delays the specific skills that are characteristically predominant at different ages (Gaddes, 1980). Thus preschool children who are delayed in perceptual-motor development as a result of a lag or delay in neurological maturation will experience difficulty in learning how to read (Satz et al., 1978). Although many of these children would eventually develop these early skills, Satz indicated that they would continue to lag in the development of conceptual-linguistic skills (and may indeed never fully develop them). In this way Satz et al., (1978) saw developmental reading disabilities as disorders in central processing which varied according to the chronological age of the child.

In a 6-year longitudinal study of 442 boys from kindergarten through grade 5, Satz and his colleagues (1978) administered a number of tests early in the kindergarten year, five of which proved to be powerful predictors of developmental reading disability: 1) finger localization, 2) visual recognition-discrimination, 3) the Beery Visual-Motor Integration Test, 4) alphabet recitation, and 5) the Peabody Picture Vocabulary Test. It is highly significant that the finger localization test, a neuropsychological measure, had the highest predictive ability of these five tests. The Finger Localization Test, like the Grip Strength Test, is one of the tests in the Reitan-Klove Sensory-Perceptual Examination
Battery which is used in the neuropsychological assessment of young children.

Grip Strength as a Measure of Neurological Maturation. Studies examining the basic structure of motor abilities in intellectually normal and mildly handicapped children have demonstrated the existence of a static strength component. Many researchers who investigate the motor traits of children include a measure of static strength, such as grip strength, in their batteries (Broadhead, 1972; Francis & Rarick, 1959). Hand grip strength is seen by many researchers to be the most reliable clinical measure of human strength and is accepted as the single item most reasonably representative of total body strength (Wessel & Nelson, 1961; Tinkle & Montoye, 1961; Heyward & McCleary, 1975).

Grip strength has been viewed as an important index of general health and as a screening test for the integrity of both the upper motor neurons and the function of the motor unit; it is also useful in the diagnosis of neuromuscular disease (Newman, Pearn, Barnes, Young, Kehoe & Newman, 1984). Grip strength has been utilized as an indicator of hand dominance (Cole, 1965; Harris, 1958). If the establishment of hand dominance is related to speech and reading disability (Kephart, 1960; Kirk, 1962; Johnson & Myklebust, 1967; Delacoto, 1959), then further insight into the nature of bi-lateral asymmetry of grip strength might be useful. Ayres (1972) indicates that some differences in the functioning of the two sides of the body can be symptomatic of different types of sensory integrative dysfunction, such as inadequate lateralization of cerebral function. Grip strength measures for both hands might provide
diagnostic information about the extent of this hemispheric dysfunction.

Oseretsky (1925) developed a motor ability scale which produced a motor age comparable to a mental age. In 1948, Sloan devised the Lincoln Adaptation of the Oseretsky Test. Johnson (1942) and Miles & Miles (1932) investigated the relationship between motor skill and intelligence and concluded that no demonstrable relationship existed. However, Abramson & LeGarrec (1937) found significant correlations between motor quotients, on one of the original Oseretsky scales, and intelligence quotients in a group of French children. Ray (1940) reported correlations of .09 to .26 between physical skill and mental achievement for groups of children with different levels of intelligence.

Fallers (1948) studied mentally defective girls and reported a slight tendency for intelligence to be positively related on the First Lincoln Adaptation of the Oseretsky Scale. In 1951, Sloan published a synopsis of his doctoral dissertation which investigated the relationship between motor proficiency and intelligence. Sloan concluded: 1) that motor proficiency is positively related to intelligence, and 2) that sex differences were not evident. These conclusions supported the suggestions of other researchers (e.g. Doll, 1946) that deficiencies in motor proficiency are associated with mental defectiveness. Turnquist (1952) later found statistically reliable differences on the First Lincoln Oseretsky Test between groups of mentally defective children and children of average intelligence. Rabin (1957) concluded, "All studies, known to this author, support the contention that motor proficiency is positively related to intelligence" (p. 515).
While the most pronounced motor deficiencies of the mentally defective are in the finer hand and finger movements, the grosser functions involving body balance and locomotion are usually affected as well (Tredgold, 1937; 1947). This is often overlooked in the educational setting as the slow learner has been traditionally relegated to those aspects of the curriculum which utilize primarily manual pursuits under the assumption that the motor capacities of these children are more nearly normal than their mental powers (Francis & Rarick, 1959). Sloan (1951) suggested that intelligence, motor proficiency and social maturity appeared to be closely related. He concluded that motor proficiency cannot be considered as an isolated function, but rather as another aspect of the total behaviour of the human organism.

Subsequent studies have demonstrated a positive relationship between gross motor performance and measured intelligence (Francis & Rarick, 1959; Ismail & Gruber, 1967). Other studies have indicated that the motor performance of mentally retarded individuals tends to be less than that of normals (Distefano, Ellis & Sloan, 1958; Londeree & Johnson, 1974; Malpass, 1960; Rarick, Widdup & Broadhead, 1970). Francis & Rarick (1959) found that at each age level the normal children for a given sex are substantially stronger than the mentally retarded; this difference increases with increasing age (i.e. the normal 8 year old male shows a grip strength equal to that of a 10 year old slow learner).

In tests using a hand dynamometer to record grip strength, it has been demonstrated that, for normal children, chronological changes in mean performance are linear and the performance of the boys is
generally superior to that of the girls (Broadhead, 1975). A similar pattern of performance has been reported for educable retardates (EMR), though the level of performance is substantially lower than that for normal children (Francis & Rarick, 1959). One research group (Newman et al., 1984) found that boys showed a continual approximately linear increase in strength throughout all age groups while girls showed an approximately linear increase up to the age of 13 years after which their mean grip strength remained relatively constant. At all ages, the girls had lower average values than boys and after puberty, this difference increased, until by age 18, boys had a mean hand grip strength 60% higher than that of girls.

Ager, Olivett & Johnson (1984) also reported that grip strength increases with age and development and that boys are consistently stronger than girls across the age range 5-12 years. Jones (1947) found that grip strength in girls levelled off at about age 13, while boys did not reach a peak until the late teens. Bowman & Katz (1984) concluded that hand grip strength in both the right and left hands was found to increase monotonically with age. Ager et al., (1984) indicated that hand dominance was not an important factor in predicting strength in their population (a conclusion supported by Burmeister, Flatt & Weiss, 1974). Similar results have been obtained in studies with adults. Swanson, Goran-Hagert & DeGroot (1978) evaluated the grasp and pinch strength of 100 adults, ages 20-60 years, using a hydraulic dynamometer and electric pinch meter. The results reported indicated that the grasp strength of males was almost twice that of females, regardless of age, occupation, and hand dominance. Dominant hand strength was only
slightly greater than that of the non-dominant hand. Fernando & Robertson (1982) found that the difference between hands was less than 10% for both sexes.

Hand grip strength appears to be an essentially continuous function of age with gradual rather than abrupt losses in strength occurring with aging. Men display greater grip strength than women and retain this superiority throughout adult life. However, men lose grip strength at a greater rate than do women; women lose dexterity at a slower rate than men (Kellor, Frost, Silberberg, Iversen & Cummings, 1971). Mathiowetz et al., (1985) report a curvilinear relationship between grip strength and age with strength peaking somewhere between ages 25 and 50 and decreasing thereafter.

Most studies of grip strength sample adults only and seldom include children under the age of 10. However, Newman et al., (1984) indicated that the most consistent grip strength readings were obtained from children ages 7-15. Finlayson (1976) indicated that in right-handed children, the right-hand left-brain superiority for strength and finger speed may be determined before age 5.

Bowman & Katz (1984) suggested that hand strength in white, right-dominant children 6-9 years old increases with age, and except for left hand strength, does not vary with sex. While height and weight are also associated with grip strength, Newman et al., (1984) found that height and weight corrections do not account for a great deal of the subject/subject variation which is unaccounted for by age class. The
authors concluded that it is doubtful that corrections for height and weight would be useful.

Precise determination of hand dominance is always difficult. Kellor et al., (1971) asked each subject which hand he/she preferred using: the percentage claiming left-handedness was quite small (consistent with the less than 10% usually found). Some individuals apparently do better with their left hand than with their right despite claiming to be right handed. Kellor et al., (1971) suggested ignoring handedness for this reason.

Many other studies ignore the issue of hand dominance due to the small percentage of left-handed subjects and instead combine the data from left-handed subjects with right-handed subjects (Fike & Rousseau, 1982; Kellor et al., 1971). In taking this approach, Mathiowetz et al., (1985) indicated that the mean right hand strength score of left hand dominant subjects was higher than their left hand scores. The relatively small difference between right hand and left hand scores suggests that some subjects will do better with their left hand even when reported to be right handed. Thus, because the mean right hand grip strength scores were higher than the mean left hand scores, Mathiowetz et al., (1985) combined scores for right and left hand dominant subjects.

The American Society of Hand Therapists suggested that researchers use a standardized arm position in measuring grip strength, concluding that "the position of the upper extremity might influence measurement, and recommended that the patient should be seated with his shoulders
adducted and neutrally rotated, elbow flexed at 90° and the forearm and wrist in neutral position" (Fess & Moran, 1981, p. 69).

Mathiowetz et al., (1984) found the highest test-retest reliabilities for each test when three trials were used. Thorngren & Werner (1979) also suggested using three consecutive trials for each hand. Other authors have used two trials per hand (Newman et al., 1984).

Provins & Cunliffe (1972b) reported test-retest reliabilities of lateral dominance measures, including grip strength, between .45 and .79 for performance rendered by the preferred hand. Coefficients for the non-preferred hand ranged between .33 and .94. Thorngren & Werner (1979) found that the ratio dominant/non-dominant hand did not show any significant difference when tested sequentially with an interval of several weeks.

Grip strength is an established subtest in the Reitan-Knove Sensory-Perceptual Examination, which is part of the Halstead Neuropsychological Test Battery for Children (Selz, 1981).

Normative (Canadian) hand grip strength data for children ages 6-12 are available (Spreen & Gaddes, 1969). The authors suggested that this data would be useful for indicating the presence of neurological dysfunction.
CHAPTER III METHOD OF STUDY

Population

This study was concerned with investigating the development of information processing skills in Native Indian children across an 8-12 age range as compared to Non-Native children, and the influence of these processing skills on reading. The target population was Native Indian children in the British Columbia school system. However, because it cannot be assumed that all Native tribal groups have had similar cultural/ecological experiences or that information processing behaviours were the same for all tribal groups, it was decided to restrict the study to children of one tribal group. For this reason the accessible population chosen was the Tsimshian Indian tribe of the North Coast of British Columbia. Replications of this study will be needed to determine if Native children from other tribal groups exhibit the same developmental patterns of information processing and reading skills.

Sampling

Seventy five Non-Native children were selected from two large elementary schools in Prince Rupert. These schools were chosen in cooperation with School District personnel to represent a full cross-section of socio-economic and ethnic groups in Prince Rupert.

Every Native child in 6 elementary schools in Prince Rupert was given an information package including a permission slip. This permission slip also required the child's parents to indicate tribal origin i.e. Tsimshian, Nishga, Haida, etc. The same procedure was followed for the
Native children in the Port Simpson and Hartley Bay community schools.

A high percentage of the City- and Village-Native children who were identified as Tsimshian volunteered to participate in the study (>85% and >90% respectively). However, the number of available children at each age level was not sufficient enough to allow for random assignment of subjects. It was assumed that the samples were representative of City- and Village-Tsimshian children because of the high participation rate of identified Tsimshian children. Since very few children identified by the parental permission slips or by school personnel did not participate in the study, if random assignment had been possible due to the addition of several more children at each age level, the sample groups would have remained the same. For this reason it is probably reasonable to assume that the samples (of 75 each) were representative of City- and Village-Tsimshian children and would behave in the same manner as randomly assigned samples.

Description of the Subjects in the Sample. The purpose of the study was to investigate the development of information processing skills in three groups of children across an 8-12 age range, and the influence of these processing skills on reading. The three groups of children were: Non-Native children residing in the north coastal city of Prince Rupert; Native children residing in Prince Rupert; and Native children residing in the isolated coastal fishing villages of Port Simpson and Hartley Bay. All of the Native children were of Tsimshian tribal origin; the Tsimshian being the dominant tribal group in the Prince Rupert area. The Prince Rupert School District was chosen because it has an enrollment of
approximately 40% Native children and presented an opportunity to gain access to Native children living in a city environment and in isolated rural communities.

Method of Obtaining the Sample. Every Non-Native child in grades 2-6 received a form explaining the objectives of the study, a supporting letter from the school principal, and a permission slip to be signed by parents. The return rate on the permission slips was >80%. Names of Non-Native children were placed on slips of paper and chosen randomly from a box by age level. Approximately equal numbers of males and females for each age level were thus randomly assigned from each school.

The City-Native children were selected from 6 elementary schools in Prince Rupert. Every Native child in grades 2-6 in these schools was given an information package including a permission slip. The permission slip required the child's parents to indicate tribal origin i.e. Tsimshian, Haida, Nishga, etc. This resulted in reducing the number of available students as many of the children who were willing to participate in the study were not of Tsimshian tribal origin. Neither the researchers nor the school personnel anticipated the variety of tribal groups represented by the City-Native children. For this reason it was necessary to utilize 6 of the 7 elementary schools in Prince Rupert in order to obtain a full sample of 75 Tsimshian children. A high percentage (>85%) of the children who were identified as Tsimshian volunteered to participate in the study. The 9 year old group in particular was difficult to obtain as few Tsimshian children in this age
range initially volunteered for the study. Additional effort had to be made to advertise the nature of the study in order to secure the 9 year old Native sample. For these reasons random assignment with the City-Native group was not possible. However, because of the high level of participation of the children identified as Tsimshian, it was assumed that the sample was reasonably representative of city Tsimshian children in Prince Rupert.

The rural Native children were enrolled in village elementary schools in the relatively isolated coastal community of Port Simpson, a Tsimshian fishing village approximately 20 minutes by float plane from Prince Rupert; and Hartley Bay, an isolated Tsimshian fishing village approximately one hour by float plane from Prince Rupert. Both communities have no road or rail link to Prince Rupert.

Every Native child in grades 2–6 in both village schools received the same informational package and permission slip. Virtually all of the children in the village schools were included in the study if the parents approved (the approval rate was >90%). All children in the sample were long-time residents of the villages and were registered on the Tsimshian band lists. Student numbers were such that both communities are represented in approximately equal numbers by grade, age, and sex. Random assignment was not possible because of the relatively small total number of students enrolled in both village schools. However, it was assumed that the sample was reasonably representative of Tsimshian children in Port Simpson and Hartley Bay because of the high participation rate of children at each age level.
Limitations of the Sample. The Non-Native, City-Native, and Village-Native children were all in the 8-12 age range and enrolled in grades 2-7 in the Prince Rupert School District. This school district was chosen because it enrolls 40% Native children, and because it presented access to city and isolated coastal village communities. All subjects were volunteers.

It is possible that the Native samples were biased because of self-selection or parental selection. Jensen (1984) suggested that such a voluntary selection process results in a larger proportion of children from lower SES homes failing to return parent permission forms. Permission was also less likely to be granted for children of low ability or poor adjustment toward school. On the other hand, parents of lower ability children might have been more apt to participate in the study as they would be more unaware or unconcerned about school-based activities.

It would be reasonable to assume that these concerns do not apply to the Village-Native group as there is very little variation in SES in the Native village communities. It was not known to what extent these concerns apply to the City-Native group as there were some differences in SES with this sample.

Full random assignment was possible with the Non-Native group because of the large number of volunteers at every age level and in both schools. Random assignment was not possible with the Village-Native group as the village schools were quite small and had a low enrollment
of elementary grade students. However, the participation rate was high enough (>90%) to allow for confidence in the representitiveness of the sample. Random assignment was also not possible with the City-Native group as many of the Native children volunteering for the study were not of Tsimshian tribal origin. However, because the percentage of city Tsimshian children volunteering was also high (>80%), it was assumed that the sample adequately represented this tribal group.
**Instrumentation**

**List of Variables Measured**

<table>
<thead>
<tr>
<th>Dependent Variables</th>
<th>Independent Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simultaneous Processing</td>
<td>Age</td>
</tr>
<tr>
<td>Gestalt Closure</td>
<td>8 year olds</td>
</tr>
<tr>
<td>Triangles</td>
<td>9 year olds</td>
</tr>
<tr>
<td>Matrix Analogies</td>
<td>10 year olds</td>
</tr>
<tr>
<td>Spatial Memory</td>
<td>11 year olds</td>
</tr>
<tr>
<td>Photo Series</td>
<td>12 year olds</td>
</tr>
<tr>
<td>Sequential Processing</td>
<td>Ethnicity</td>
</tr>
<tr>
<td>Hand Movements</td>
<td>Village-Native children</td>
</tr>
<tr>
<td>Number Recall</td>
<td>Non-Native children</td>
</tr>
<tr>
<td>Word Order</td>
<td>City-Native children</td>
</tr>
<tr>
<td>Reading Subtests</td>
<td>Sex</td>
</tr>
<tr>
<td>Word Identification</td>
<td>males</td>
</tr>
<tr>
<td>Passage Comprehension</td>
<td>females</td>
</tr>
<tr>
<td>Reading Understanding</td>
<td></td>
</tr>
<tr>
<td>Neurological Maturation</td>
<td></td>
</tr>
<tr>
<td>Dominant Hand Grip Strength</td>
<td></td>
</tr>
<tr>
<td>Other Hand Grip Strength</td>
<td></td>
</tr>
</tbody>
</table>
All of the dependent variables applied at every level of the independent variables i.e. every child of both sexes, at every age level, in all three cultural groups received the same battery of tests.

**Dependent Variables.** The dependent variables in the study were:

1. **Simultaneous Processing:** involves gestalt-like, holistic processing of individual stimuli arriving at the brain in primarily spatial groups. The essential aspect of this type of processing is that any portion of the result is at once surveyable without dependence on its position in the whole (Das et al, 1975). Simultaneous processing is required in the formation of any holistic gestalt or in the discovery of the relationships among two or more objects and involves spatial or analogic components.

2. **Sequential Processing:** involves the integration of individual stimuli into temporal or serial order. Each bit of information is related to the preceding one, either temporally or logically, and problems are solved in a linear rather than in a holistic manner with bits of information being processed in response to cues in a step-by-step manner (Gunnison et al., 1982).

Simultaneous and Sequential Processing are two of the subscales comprising the Mental Processing Scale of the K-ABC.
Description of the K-ABC Mental Processing Scale Subtests.

<table>
<thead>
<tr>
<th>K-ABC Mental Processing Subtests</th>
<th>Required Response by the Child</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simultaneous Processing</td>
<td></td>
</tr>
<tr>
<td>Gestalt Closure</td>
<td>Identify incomplete inkblot drawings.</td>
</tr>
<tr>
<td>Triangles</td>
<td>Assemble foam triangles to match a picture model.</td>
</tr>
<tr>
<td>Matrix Analogies</td>
<td>Select a design to complete a visual analogy.</td>
</tr>
<tr>
<td>Spatial Memory</td>
<td>Identify placement of previously exposed pictures on a blank grid.</td>
</tr>
<tr>
<td>Photo Series</td>
<td>Arrange photographs in chronological order.</td>
</tr>
<tr>
<td>Sequential Processing</td>
<td></td>
</tr>
<tr>
<td>Hand Movements</td>
<td>Copy a series of hand movements.</td>
</tr>
<tr>
<td>Number Recall</td>
<td>Repeat a series of digits.</td>
</tr>
<tr>
<td>Word Order</td>
<td>Point to a series of named silhouettes</td>
</tr>
</tbody>
</table>

Validity-Reliability of the K-ABC. There has been considerable factor analytic support for the existence of the simultaneous and sequential dichotomy that forms the foundation of the K-ABC (Kaufman & Kamphaus, 1984). Willson et al., (1983) indicates that confirmatory factor analysis offers support for all three K-ABC dimensions (Simultaneous, Sequential, and Achievement) across the entire 2 1/2 - 12 1/2 age range of the battery.
Other researchers (Obrzut et al, 1984) reported a high correlation between the Mental Processing Scales and the WISC-R and suggested that this offers evidence of the construct validity of the K-ABC. Naglieri & Haddad (1984) offered evidence of the construct validity of the K-ABC as a measure of ability and achievement.

Simultaneous and sequential processing appear to correlate equally well with various measures of reading, with composite scores on various achievement batteries, and with verbal intelligence (Kaufman & Kaufman, 1983c). The average of all coefficients reported in Table 1 of the Interpretive Manual (Kaufman & Kaufman, 1983c) was .453 for sequential processing and .475 for simultaneous processing. However, other researchers have questioned the validity of the K-ABC.

The reliability estimates reported in the K-ABC Interpretive Manual (Kaufman & Kaufman, 1983c) appear to be comparable to other accepted intelligence and achievement tests (Kamphaus & Reynolds, 1984). The average reliability coefficients as reported in the Interpretive Manual (Kaufman & Kaufman, 1983c) for ages 5 1/2 - 12 1/2 were .89 and .93 for the sequential and simultaneous processing scales respectively.

3. **Word Identification**: this B.C. QUIET subtest is a measure of the decoding of words in independent word lists, and provides a convenient evaluation of a subject's sight vocabulary and decoding skills.

4. **Passage Comprehension**: this is another B.C. QUIET subtest which provides a measure of a child's ability to understand the meaning of
words grouped into phrases, sentences, and paragraphs. This subtest utilizes a cloze procedure and requires a verbal response by the child.

Validity-Reliability of the B.C. QUIET. Content validity of the B.C. QUIET is assumed to be high for B.C. children as all test items were chosen from B.C. Ministry of Education curricula and materials commonly in use throughout the Province of British Columbia. Empirical validity was demonstrated by the ability of the B.C. QUIET to correctly classify groups of children in grades 3 and 6 enrolled in learning assistance or other remedial programs. The overall classification rate was 93.8% for the grade 3 group and 95.4% for the grade 6 group. High correlations have been reported between the B.C. QUIET and the Woodcock-Johnson: Achievement Battery (.76 to .87). The authors concluded that the B.C. QUIET had satisfactory concurrent validity (Hardman & Oldridge, 1985).

5. **Reading Understanding:** a K-ABC reading comprehension subtest utilizing a rather unique response strategy. The child is required to read a sentence(s) and then act out the meaning of the selection i.e. point at the nearest adult. It was felt that this response strategy would be more culture-fair with Native children than the verbal response requirements of the Passage Comprehension subtest.

The Word Identification, Passage Comprehension, and Reading Understanding subtests were selected to provide measures of the child's early reading (decoding) and advanced reading (comprehension) skills.

6. **Grip Strength:** involves measuring the hand grip strength of both
hands with a clinical sphygmomanometer. Three readings were taken for each hand, the mean of the three readings being recorded for that hand. Grip Strength is an established subtest in the Halstead Neuropsychological Test Battery for Children (Selz, 1981), and is useful for indicating the presence of neurological dysfunction (Spreen & Gaddes, 1969). Satz and his colleagues (Satz & Sparrow, 1970; Satz et al., 1978) suggest that neurological maturational lag can account for developmental dyslexia. This theoretical position assumes that reading disabilities are a reflection of a lag in cerebral maturation which in turn differentially delays the specific skills that are characteristically predominant at different age levels (Gaddes, 1980). By measuring a child's level of neurological maturation (grip strength), we should obtain a variable that will demonstrate the same developmental pattern as the child's reading scores.

**Validity-Reliability of the Grip Strength Test.** Several researchers have indicated that a reliable record of hand grip dynamics can be made with relatively inexpensive equipment (Myers et al., 1980; Fernando & Robertson, 1982), although more expensive/sophisticated equipment is available. The use of an inflated cuff bag (sphygmomanometer) may be preferable with young children as they can easily fit their hands to the bag (Myers et al., 1980).

Grip strength has been reported to be a continuous function of age (Kellor et al., 1971). Newman et al., (1984) indicated that the most consistent grip strength readings were obtained from children ages 7-15. Finlayson (1976) suggested that in right-handed children, the right-hand
left-brain superiority for strength and finger speed may be determined before age 5.

Grip strength is an established subtest on the Halstead Neuropsychological Test Battery for Children (Selz, 1981). Gaddes (1980) suggested that the Dynometer Grip Strength Test should be considered a sensitive indicator of central nervous system damage or dysfunction and a reliable correlate of learning disorders.

Mathiowitz et al., (1984) found the highest test-retest reliabilities for each test when three trials were used. Thorngren & Werner (1979) also suggested using three consecutive trials for each hand. Provins & Cunliffe (1972b) reported test-retest reliabilities of lateral dominance measures, including grip strength, between .45 and .79 for performance rendered by the preferred hand, and between .33 and .94 for the non-preferred hand.

**Independent Variables.** The independent variables in the study were:

1. **Age:** because the study attempted to measure the developmental nature of information processing and reading, the sample had to reflect an age range covered by both the K-ABC and B.C. QUIET. Since the K-ABC can be used with children up to the age of 12 1/2, and the B.C. QUIET (Word Identification and Passage Comprehension subtests) from grades 2-7, it was decided to limit the range of the sample to ages 8-12 (or grades 2-7). Five age levels were established with age determined as years ±6 months at the time of testing.
2. **Sex**: due to possible sex differences on the dependent measures, the sample of children was balanced for sex at every age level. It was subsequently determined that sex was not a relevant variable and thus was dropped from the analysis of the data.

3. **Ethnicity**: one of the primary purposes of the study was to examine the possibility of cultural group differences in information processing. For this reason it was necessary to compare Native children living a more traditional (village) lifestyle to City-Native and city Non-Native children. A comparable group of village Non-Native children simply does not exist in the Prince Rupert region.

**Administration.**

All children were tested in their elementary schools of attendance. The K-ABC was administered by the writer for the entire sample of 225 children. The B.C. QUIET/K-ABC reading subtests were administered to the Non-Native and Village-Native children by the same graduate student examiner. A second graduate student examiner administered the B.C. QUIET/K-ABC Reading subtests to the City-Native children.

Each child was required to attend one testing session of approximately 75–90 minutes duration with a break of approximately 5 minutes in the middle. During this break, the child had the opportunity to get up and move around, have a rest, and change examiners. The tests were administered in counterbalanced order as there were usually two children with the examiners at a time.
The first test administered to every child was the Test of Colour Blindness (Ishihara, 1977). It was felt that colour blindness would seriously impair a child's ability to function on the K-ABC. Only two colour blind children were detected in the entire sample; both were eliminated from further testing.

The Grip Strength Test was administered to every child prior to the K-ABC (by the same examiner for all 225 children). A clinical sphygmomanometer (produced by the W.A. Baum Co. Ltd., Copiague, N.Y.) was used. The children were required to squeeze a rectangular air-filled bladder which was attached to a blood pressure manometer and registered grip strength in millimeters of mercury. This instrumentation was used successfully by previous researchers (Myers, Grennan & Palmer, 1980). The same sphygmomanometer, bladder, and manometer was used by all subjects.

Grip Strength was recorded for left/right hands and dominant/other hands. Dominant hand was indicated by asking the child to pick up a pencil placed on the table in the mid-line of the body and write their name. The child was then asked to rest the elbow on the table with the forearm in a 45° angle to the table but forming a 90° angle with the upper arm. The child was also required to sit upright with shoulders facing the sphygmomanometer (Fess & Moran, 1981; Mathiowetz et al., 1985) and to grip the bladder in a "handshake" position, taking care not to let the bladder press against the table or any other part of the body (Fernando & Robertson, 1982).
Three trials were given with each hand (Schmidt & Toews, 1970; Thorngren & Werner, 1979) interspaced by 30 seconds of rest to minimize fatigue as a factor (Bowman & Katz, 1984); the ratings for each hand being the mean of the three trials (Thorngren & Werner, 1979; Mathiowetz et al., 1984). The order of measuring the right and left hands was randomized (Bowman & Katz, 1984). The sphygmomanometer was recalibrated after each trial (Schmidt & Toews, 1970; Mathiowetz et al., 1985).

Scoring.

Every protocol (K-ABC and B.C. QUIET) was scored twice by the same examiner, and then scored a third time by a graduate student who was not involved in the testing.

Transformation of Scores.

All subtest scores used in the study were raw scores; the Simultaneous and Sequential Processing scores were scaled according to the procedure given in the K-ABC Administration and Scoring Manual (Kaufman & Kaufman, 1983b).

Data Collection and Processing.

All student responses were recorded on standard protocols for the K-ABC and B.C. QUIET. Since both of these tests involved rather simple scoring procedures, it was not difficult to check for errors in scoring
(every protocol was checked three times). There was no missing data as every child in each of the groups completed all required test items and each group at every grade level contained the same number of children.

Raw scores for each subtest and scaled scores for Simultaneous and Sequential Processing were entered on Fortran coding sheets (this procedure was also checked three times). This data was then entered into a data file in the computing center at the University of British Columbia for further analysis.

Research Design

The design used was non-experimental in nature and involved a 3x5 factorial design in which there were two factors, Age and Ethnicity. The Ethnicity factor consisted of 3 levels: Village-Native, Non-Native, and City-Native children; while the Age factor consisted of 5 levels, age wise. While equal numbers of males and females were initially chosen for each sample at every age level, sex was eventually dropped when it proved to be non-significant. Finally, a balanced 3x5 factorial design was used with 15 subjects in each cell for a total of 75 subjects per ethnic group. The samples of 15 children per age level consisted of either 7 males and 8 females or 8 males and 7 females according to subject availability. Each subject was administered the same battery of tests in counterbalanced order. There were no missing data.
Statistical Hypotheses.

1. There will be no statistically significant difference at the $\alpha = .05$ level on mean scores on a weighted linear composite of Simultaneous and Sequential Information Processing tasks for Ethnicity, Age, Sex, and joint effects of these factors.

2. There will be no statistically significant difference at the $\alpha = .05$ level between mean scores on a weighted linear composite of Simultaneous and Sequential Information Processing Subtest tasks for Ethnicity, Age, Sex, and joint effects of these factors.

3. There will be no statistically significant difference at the $\alpha = .05$ level between mean scores on a weighted linear composite of Reading tasks for Ethnicity, Age, Sex, and joint effects of these factors.

4. There will be no statistically significant difference at the $\alpha = .05$ level between mean scores on a weighted linear composite of Neurological Maturation tasks for Ethnicity, Age, Sex, and joint effects of these factors.

Method of Analysis

1. Mean Scores and Standard Deviations: for the dependent variables in each cell are presented in Tables 1-3. Multivariate analysis was applied to the data presented.
2. **Canonical Analysis (CA):** A canonical analysis on two sets of variables, a set of dependent variables and a set of independent variables, was initially carried out to determine the strength of relationship between the two sets of variables and the complexity of the relationship. The set of dependent variables included Simultaneous and Sequential Processing, the Word Identification, Passage Comprehension, and Reading Understanding Subtests, and the Dominant Hand Grip Strength and Other Hand Grip Strength Subtests; the set of independent variables contained Ethnicity, Age, and Sex. In the initial analysis, only the total scores on the dependent variables were used. In subsequent canonical analyses, scores on the subtests of each dependent variable were included in the dependent variable set.

Canonical analysis has been termed most appropriate for examining the relationship between two sets of variables (Colley & Lohnes, 1971; Green, 1978; Levin, 1977; and Thorndike, 1977).

The objective of canonical correlation is to generate pairs of variable combinations (canonical variates) so that the correlations between them are maximized.

If there is one set of p variables and one set of q variables, the principal objective of canonical correlation analysis is to find a linear combination of the p variables that correlates maximally with a linear combination of the q variables and, for sample data, to test the statistical significance of that correlation (Knapp, 1982, p. 23).

Thus canonical correlation is the maximum correlation between pairs of linear composites of variables from two different variable sets.
Subject to the restriction of variate orthogonality, new pairs of variates are formed from residual variances with the maximum number of pairs being equal to the number of variables in the smaller of the two sets. Hence each canonical variate is a constructed, unobserved variable, regressed on the observed variables within that set (Fornell, 1982, p. 37).

In this way canonical correlation analysis provides us with an examination of the overall significance and magnitude of relationships between two sets of variables. The objective of the analysis is to determine the complexity and the nature of that relationship; the complexity of the relationship is reflected in the number of significant canonical correlations.

The first canonical correlation coefficient is the largest and therefore represents the most significant relationship; the second correlation coefficient is the second largest after the effect of the first set has been removed. The decision as to when to stop extracting canonical variate pairs is quite subjective, however, there is seldom a good case for interpreting relationships that are below a reasonable statistical significance (Fornel, 1982).

A number of basic assumptions underlie canonical correlation analysis:
1) That no collinearities, or near collinearities, should appear in either the dependent or independent variable sets. Thus variables that are highly correlated with other variables within the same set should not be included.

2) That sample size N should be large compared to the total number of
variables, P+Q, to ensure that the resulting solution is stable (Marascuilo & Levin, 1983).

A canonical analysis is enhanced if the variables are normally distributed. The normality of the variables can be determined by an examination of skewness and kurtosis (Tabachnick & Fidell, 1983).

All standardized score values (the smallest and largest Z-score values) should be within ±3.00 standard score units which indicates the absence of outliers. None of the variables can be too highly correlated with, or be near linear combinations of the other variables in the same set (r < .95) in order to avoid multicollinearity (Tabachnick & Fidell, 1983). A data plot can be used to indicate that the assumption of linearity between the first canonical variates was warranted.

A test of statistical significance must be applied in order to determine whether or not large sample canonical correlations represent real departures from chance relationships. Marascuilo & Levin (1983) recommend a formal statistical criteria, Bartlett's Test, which is based on partitioning the Chi-square statistic associated with Wilks' Lambda, sequentially to each of the canonical correlations. The use of Bartlett's Test allows us to determine how many variate pairs should enter the analysis.

Significance is thus determined by examining the canonical correlations, the Eigenvalues (which represent the percentage of overlapping variance between the first pair of canonical variates), and the
results of the Chi-square Test. Correlations with r values of .30 or less are usually not interpreted even if they are significant because they represent (squared) less than 10% of the variance (Tabachnick & Fidell, 1983).

We then test for redundancy to determine the statistical overlap between the two sets of variables, and then interpret the "meaning" of the variates and/or assess the "importance" of the variables from the relative size of the standardized canonical weights (Tabachnick & Fidell, 1983).

The structure coefficients indicate what the significant relationships are in the dimensions underlying the dependent (and independent) variables. The average amount of variance of a canonical variate that can be attributed to the original set of variables involved in the variate is called the Percentage of Variance. I.e. The percentage of the variance in the first Y-composite accounted for by the variables underlying that variate.

The Redundancy Index indicates the proportion of variance of the variables of one set that is accounted for by the linear combination of the variables of the other set.

When the canonical correlation between the sets of variables was high, prediction between the sets was also expected to be high (Thorndike, 1977). If there was reasonable predictive power between the sets of variables and if the structure coefficients allowed us to determine the specific nature of the relationship between the sets of variables, then
further analysis was applied by means of ANOVA of the canonical variable loading scores (Z-scores). Where appropriate, post-hoc pairwise comparison of group means were applied to determine the significance of mean differences between groups.

3. **Analysis of Variance (ANOVA):** Corresponding to the research hypotheses, different canonical variates were used as criterion variables in the ANOVA’s. The independent variables in each ANOVA were determined from the structure coefficients of the independent variables in each CA. Consequently, depending on the size of the canonical correlation and structure coefficients obtained in each CA, the factors tested in each ANOVA varied. Figure 1 below shows, schematically, the most general design used and the number of subjects in each ethnic group. As suggested above, depending on the outcome of the CA, the general design was reduced, on occasion, to a univariate one-way, fixed-effects design.
Figure 1: Research Design with Three Levels of Ethnicity and Five Levels of Age.

<table>
<thead>
<tr>
<th></th>
<th>A Ethnicity</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Village Native</td>
<td>n=15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>Non-Native</td>
<td>n=15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>City Native</td>
<td>n=15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>45</td>
<td>45</td>
<td>45</td>
<td>45</td>
<td>45</td>
<td>N=225</td>
</tr>
</tbody>
</table>

Following the ANOVA's, post-hoc analyses were carried out to determine the levels of each independent variable or factor found to be statistically significant in accounting for the variance in the scores of the new dependent variables. Graphs of cell means on the dependent variables against age were presented to highlight the results.
CHAPTER IV RESULTS OF THE STUDY

This chapter will present summary descriptive data and the results of the analysis of the data relevant to each research hypothesis and statistical hypothesis stated in Chapter I. Each research hypothesis will be stated first, then the corresponding statistical hypothesis, and finally the results of the statistical tests followed by an interpretation of the results of the tests relevant to the research hypothesis.

Summary of Descriptive Data.

An examination of the means for Simultaneous and Sequential Processing presented in Tables 1-3 reveals that the Village-Native group exhibits lower scores than the City-Native group at every age level with the Non-Native group exhibiting scores intermediate between the two Native groups. There does not appear to be a significant trend in the scores according to Age.

The Simultaneous and Sequential Processing Subtests (Hand Movements, Gestalt Closure, Number Recall, Triangles, Word Order, Matrix Analogies, Spatial Memory, and Photo Series) present the same relationship between the three Ethnic groups with the City-Native group exhibiting higher mean scores than the Village-Native group at all age levels. This relationship is also evident on the three reading subtests, Word Identification, Passage Comprehension, and Reading Understanding, and on the two neurological maturation subtests, Dominant Hand Grip.
Strength and Other Hand Grip Strength. The scores on some subtests, for the Village-Native, Non-Native, and City-Native groups, suggest a linear trend with Age.

Since intercorrelations appear very likely between the dependent variables, multivariate analysis was undertaken in order to take such interrelationships into account.
<table>
<thead>
<tr>
<th>A  (Ethnicity)</th>
<th>Dependent Variables</th>
<th>$\bar{X}$</th>
<th>$\text{SD}$</th>
<th>B  (Age)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Village-Native</td>
<td>Simultaneous</td>
<td>96.80</td>
<td>89.47</td>
<td>94.47</td>
</tr>
<tr>
<td></td>
<td>Processing</td>
<td>10.48</td>
<td>8.85</td>
<td>11.48</td>
</tr>
<tr>
<td></td>
<td>Sequential</td>
<td>93.40</td>
<td>86.40</td>
<td>98.00</td>
</tr>
<tr>
<td></td>
<td>Processing</td>
<td>7.56</td>
<td>9.36</td>
<td>13.86</td>
</tr>
<tr>
<td></td>
<td>Hand Movements</td>
<td>9.13</td>
<td>9.33</td>
<td>11.47</td>
</tr>
<tr>
<td></td>
<td>Gestalt Closure</td>
<td>15.87</td>
<td>16.40</td>
<td>18.07</td>
</tr>
<tr>
<td></td>
<td>Number Recall</td>
<td>10.07</td>
<td>9.53</td>
<td>11.87</td>
</tr>
<tr>
<td></td>
<td>Triangles</td>
<td>12.00</td>
<td>11.80</td>
<td>14.00</td>
</tr>
<tr>
<td></td>
<td>Word Order</td>
<td>10.87</td>
<td>10.27</td>
<td>13.13</td>
</tr>
<tr>
<td></td>
<td>Matrix Analogies</td>
<td>8.40</td>
<td>9.13</td>
<td>9.93</td>
</tr>
<tr>
<td></td>
<td>Spatial Memory</td>
<td>12.87</td>
<td>12.07</td>
<td>14.53</td>
</tr>
<tr>
<td></td>
<td>Photo Series</td>
<td>9.00</td>
<td>8.93</td>
<td>10.87</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.33</td>
<td>2.34</td>
<td>2.07</td>
</tr>
<tr>
<td></td>
<td></td>
<td>28.73</td>
<td>30.33</td>
<td>48.67</td>
</tr>
<tr>
<td></td>
<td>Word Identification</td>
<td>12.81</td>
<td>12.06</td>
<td>16.09</td>
</tr>
<tr>
<td></td>
<td>Passage</td>
<td>6.53</td>
<td>8.33</td>
<td>12.53</td>
</tr>
<tr>
<td></td>
<td>Comprehension</td>
<td>3.62</td>
<td>4.58</td>
<td>5.29</td>
</tr>
<tr>
<td></td>
<td>Reading</td>
<td>7.20</td>
<td>7.47</td>
<td>12.13</td>
</tr>
<tr>
<td></td>
<td>Understanding</td>
<td>3.41</td>
<td>3.91</td>
<td>3.98</td>
</tr>
<tr>
<td></td>
<td>Grip Strength</td>
<td>55.67</td>
<td>68.93</td>
<td>75.87</td>
</tr>
<tr>
<td></td>
<td>Dominant Hand</td>
<td>11.65</td>
<td>10.69</td>
<td>14.57</td>
</tr>
<tr>
<td></td>
<td>Grip Strength</td>
<td>57.27</td>
<td>68.53</td>
<td>77.20</td>
</tr>
<tr>
<td></td>
<td>Other Hand</td>
<td>10.07</td>
<td>13.85</td>
<td>15.49</td>
</tr>
</tbody>
</table>
Table 2: Means and Standard Deviations for Non-Native Children at Each Age Level.

<table>
<thead>
<tr>
<th>A (Ethnicity)</th>
<th>Dependent Variables</th>
<th>X</th>
<th>B (Age)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>SD</td>
<td>8</td>
</tr>
<tr>
<td>Non-Native</td>
<td>Simultaneous</td>
<td></td>
<td>101.13</td>
</tr>
<tr>
<td></td>
<td>Processing</td>
<td></td>
<td>13.10</td>
</tr>
<tr>
<td></td>
<td>Sequential</td>
<td></td>
<td>94.07</td>
</tr>
<tr>
<td></td>
<td>Processing</td>
<td></td>
<td>6.57</td>
</tr>
<tr>
<td></td>
<td>Hand Movements</td>
<td></td>
<td>10.27</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2.05</td>
</tr>
<tr>
<td>Non-Native</td>
<td>Gestalt Closure</td>
<td></td>
<td>15.87</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3.66</td>
</tr>
<tr>
<td></td>
<td>Number Recall</td>
<td></td>
<td>10.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.41</td>
</tr>
<tr>
<td></td>
<td>Triangles</td>
<td></td>
<td>13.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.77</td>
</tr>
<tr>
<td></td>
<td>Word Order</td>
<td></td>
<td>10.80</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.86</td>
</tr>
<tr>
<td></td>
<td>Matrix Analogies</td>
<td></td>
<td>10.33</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3.58</td>
</tr>
<tr>
<td></td>
<td>Spatial Memory</td>
<td></td>
<td>13.93</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2.55</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2.13</td>
</tr>
<tr>
<td></td>
<td>Word Identification</td>
<td></td>
<td>34.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10.05</td>
</tr>
<tr>
<td></td>
<td>Passage</td>
<td></td>
<td>7.33</td>
</tr>
<tr>
<td></td>
<td>Comprehension</td>
<td></td>
<td>2.74</td>
</tr>
<tr>
<td></td>
<td>Reading</td>
<td></td>
<td>8.13</td>
</tr>
<tr>
<td></td>
<td>Understanding</td>
<td></td>
<td>3.54</td>
</tr>
<tr>
<td></td>
<td>Grip Strength</td>
<td></td>
<td>69.40</td>
</tr>
<tr>
<td></td>
<td>Dominant Hand</td>
<td></td>
<td>16.16</td>
</tr>
<tr>
<td></td>
<td>Grip Strength</td>
<td></td>
<td>69.47</td>
</tr>
<tr>
<td></td>
<td>Other Hand</td>
<td></td>
<td>16.89</td>
</tr>
</tbody>
</table>
Table 3: Means and Standard Deviations for City-Native Children at Each Age Level.

<table>
<thead>
<tr>
<th>A (Ethnicity)</th>
<th>Dependent Variables</th>
<th>X</th>
<th>B (Age)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>SD</td>
<td>8</td>
</tr>
<tr>
<td>City-Native</td>
<td>Simultaneous</td>
<td></td>
<td>103.60</td>
</tr>
<tr>
<td></td>
<td>Processing</td>
<td></td>
<td>103.60</td>
</tr>
<tr>
<td></td>
<td>Sequential</td>
<td></td>
<td>102.67</td>
</tr>
<tr>
<td></td>
<td>Processing</td>
<td></td>
<td>102.67</td>
</tr>
<tr>
<td>City-Native</td>
<td>Hand Movements</td>
<td></td>
<td>11.73</td>
</tr>
<tr>
<td></td>
<td>Gestalt Closure</td>
<td></td>
<td>16.60</td>
</tr>
<tr>
<td></td>
<td>Number Recall</td>
<td></td>
<td>10.60</td>
</tr>
<tr>
<td></td>
<td>Triangles</td>
<td></td>
<td>13.40</td>
</tr>
<tr>
<td></td>
<td>Word Order</td>
<td></td>
<td>12.33</td>
</tr>
<tr>
<td></td>
<td>Matrix Analogies</td>
<td></td>
<td>9.07</td>
</tr>
<tr>
<td></td>
<td>Spatial Memory</td>
<td></td>
<td>12.73</td>
</tr>
<tr>
<td></td>
<td>Photo Series</td>
<td></td>
<td>10.47</td>
</tr>
<tr>
<td></td>
<td>Word Identification</td>
<td></td>
<td>35.13</td>
</tr>
<tr>
<td></td>
<td>Passage</td>
<td></td>
<td>12.69</td>
</tr>
<tr>
<td></td>
<td>Comprehension</td>
<td></td>
<td>10.60</td>
</tr>
<tr>
<td></td>
<td>Reading</td>
<td></td>
<td>5.32</td>
</tr>
<tr>
<td></td>
<td>Understanding</td>
<td></td>
<td>9.60</td>
</tr>
<tr>
<td></td>
<td>Grip Strength</td>
<td></td>
<td>5.03</td>
</tr>
</tbody>
</table>

City-Native Dominant hand: 13.78 14.77 13.98 18.38 25.97
City-Native Grip Strength: 64.27 80.53 79.27 92.47 106.07
City-Native Other hand: 13.22 17.55 18.03 24.61 24.57
Research Hypothesis 1.

There will be no statistically significant difference at the $\alpha = .05$ level on mean scores on a weighted linear composite of Simultaneous and Sequential Information Processing tasks for Ethnicity, Age, Sex, and joint effects of these factors.

Statistical Hypothesis 1.

$H_0: R_{ci} = 0$

The canonical correlations between the two sets of variables, dependent and independent, for the population, will not be significantly correlated statistically at the $\alpha = .05$ level of significance.

Results of Testing Statistical Hypothesis.

1. Canonical Analysis (CA):

A canonical correlation analysis was performed using BMDP6M (Dixon, 1981) between a set of grouping variables (Ethnicity, Age, and Sex) and a set of Information Processing variables (Simultaneous and Sequential Processing). There were 5 Age levels (8-12), 3 Ethnic groups (Village-Native, Non-Native, and City-Native children), and 2 levels of Sex.

Assumptions. An examination of the assumption of normality basic to a canonical analysis was upheld: skewness and kurtosis of each independent variable was not excessive. The assumption of non-multicollinearity was upheld (see Table 4) since the multiple correlations of every variable in each set with all other variables in the
Figure 2: Linearity of Relationship Between the First Canonical Variates.
same set was ≤.20 (Tabachnick & Fidell, 1983). Figure 2 indicates that the assumption of a linear relationship between the first pair of canonical variates, was reasonable. All standardized score values were within ±3.00 standard score units which indicated no serious outliers. There was no missing data.

Table 4: Canonical Analysis: Test for Multicollinearity of Variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>R-Squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simultaneous Processing</td>
<td>0.20</td>
</tr>
<tr>
<td>Sequential Processing</td>
<td>0.20</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th>R-Squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethnicity</td>
<td>0.00</td>
</tr>
<tr>
<td>Age</td>
<td>0.00</td>
</tr>
<tr>
<td>Sex</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Results. The canonical correlation and the results of the Chi-square test for statistical significance of the canonical correlations are contained in Table 5. The first canonical correlation was 0.45; the second was not statistically significant at the α = .05 level. The Chi-square test for the first canonical correlation was statistically significant: Chi-square (6) = 52.95; p < 0.00.
Table 5: Bartlett’s Test for Significance of Eigenvalues.

<table>
<thead>
<tr>
<th>Eigenvalue</th>
<th>Canonical Correlation</th>
<th>Chi-Square</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.20</td>
<td>Rc1 = 0.45</td>
<td>52.95</td>
<td>6</td>
<td>0.00</td>
</tr>
</tbody>
</table>

The summary statistics for the canonical correlation analysis are provided in Table 6. The first pair of canonical variates, $Y(1)$ and $X(1)$, are contained in Column I. The structure coefficients, which are the correlations between the canonical variates and the original variables, are contained in Column IA. The relative importance of each of the original variables to the corresponding canonical variate is illustrated by the standardized canonical weights in Column IB.

The structure coefficients and standardized canonical weights (presented in Column IA and IB) indicate that the first dimension underlying the dependent variables is a mental processing dimension with structure coefficients of 0.86 for Sequential Processing and 0.84 for Simultaneous Processing. Similarly, the first dimension underlying the independent variables is primarily an Ethnicity dimension, with a structure coefficient of 0.97, and a weak involvement of Sex, with a structure coefficient of 0.26, and almost no involvement of Age, with structure coefficient -0.09. This would suggest that Simultaneous and Sequential Information Processing bears a significant relationship to Ethnic group membership.
Table 6: Summary Statistics for Canonical Correlation of Ethnicity, Age, and Sex with Simultaneous and Sequential Processing.

<table>
<thead>
<tr>
<th></th>
<th>First Canonical Variate</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>A</strong></td>
<td><strong>B</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Structure Coefficients</strong></td>
<td>0.84</td>
<td>0.57</td>
<td></td>
</tr>
<tr>
<td><strong>Standardized Coefficients</strong></td>
<td>0.86</td>
<td>0.61</td>
<td></td>
</tr>
</tbody>
</table>

**Dependent Variable Set**

<table>
<thead>
<tr>
<th></th>
<th>Simultaneous Processing</th>
<th>Sequential Processing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of Variance</td>
<td>72%</td>
<td>14%</td>
</tr>
</tbody>
</table>

**Independent Variable Set**

<table>
<thead>
<tr>
<th></th>
<th>Ethnicity</th>
<th>Age</th>
<th>Sex</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of Variance</td>
<td>34%</td>
<td>07%</td>
<td></td>
</tr>
</tbody>
</table>

*Structure coefficients >.30 are underlined and considered meaningful (Tabachnick & Fidell, 1983; Pedhazur, 1982).*
The average amount of variance of a canonical variate that can be attributed to the original set of variables involved in the variate is called the Percentage of Variance. In this canonical analysis, the original Y-variables account for 72% of the variance in the first canonical variate $[\hat{Y}(1)]$. This means that only 28% of the variance in the first Y-composite is not accounted for by the two mental processing variables (Simultaneous and Sequential Processing).

The Redundancy Index indicates the proportion of variance of the variables of one set that is accounted for by the linear combination of the variables of the other set. For the first canonical variate $[\hat{Y}(1)]$, 14% of the variance is accounted for by the variables in the independent variable set (Ethnicity, Age, and Sex). This means that 14% of the variance on the Simultaneous and Sequential Processing set $[\hat{Y}(1)]$ is predictable from the linear combination of the independent variable set (Ethnicity, Age, and Sex) on the first canonical variate (which suggests rather low predictive power).

An examination of the standardized coefficients (Column IB) indicates the relative order of importance of the variables on the underlying dimension, for the first set was: Simultaneous and Sequential Processing (0.61 and 0.57 respectively); and for the second set, Ethnicity (0.96), Sex (0.23), and Age (-0.07).

Both the structure coefficients and the pattern analysis of the standardized weights suggest that Ethnic group membership bears a significant relationship with Simultaneous and Sequential Information Processing.
Summary. The results of this canonical analysis led to a rejection of Ho since $R_{c1}$ was statistically significant at the .05 level. Both the pattern analysis and the structure coefficients from the canonical analysis suggest that the two dependent variables were almost equally weighted on the first linear composite of dependent variables. This was interpreted to mean that both Simultaneous and Sequential Processing correlate fairly equally with the underlying construct. This construct was interpreted to be a general cognitive construct having to do with Information Processing. However, both the pattern analysis and the structure coefficients indicated that only Ethnicity correlated highly with the latent construct underlying the independent variables. Therefore, the construct was considered to be an Ethnic dimension. To summarize, Research Hypothesis 1 was rejected in favour of the conclusion that Ethnicity is significantly correlated to the underlying cognitive construct of Information Processing.

2. ANOVA:

An ANOVA was applied to the standardized scores on the first canonical variate, $\hat{Y}(1)$, as scores on a single dependent variable, and Ethnicity as the independent variable, since the canonical analysis suggested a significant correlation between these two variables. The ANOVA design used was based on a one-way, fixed-effects model with three levels of the Ethnicity factor.

The results of this ANOVA confirms the canonical analysis by indicating a significant relationship between Ethnicity and the latent construct underlying $\hat{Y}(1)$. Table 7 summarizes the results of the ANOVA.
Table 7: ANOVA for Canonical Variate Scores, $\hat{Y}(1)$, for the Factor Ethnicity.

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>210.48</td>
<td>2</td>
<td>105.24</td>
<td>1729.44</td>
<td>0.00</td>
</tr>
<tr>
<td>Within Groups</td>
<td>13.51</td>
<td>222</td>
<td>0.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>223.99</td>
<td>224</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A Scheffé post-hoc pairwise comparison of the group means on $\hat{Y}(1)$ for the three levels of Ethnicity revealed significant differences between all pairs of group means.

Table 8: Scheffé Post-Hoc Pairwise Comparison of Group Means on $\hat{Y}(1)$ for Three Ethnicity Groups.

<table>
<thead>
<tr>
<th>Group Mean</th>
<th>Group 1 (NatVil)</th>
<th>Group 2 (NonNat)</th>
<th>Group 3 (NatCit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1.18</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.00</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>1.18</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

* pairwise contrasts of means significantly different at the .05 level.

Table 8 indicates that all three Ethnic groups differed significantly
on the composite dependent variable of Simultaneous and Sequential Information Processing. The means of the standardized scores on $\tilde{Y}(1)$ of the three Ethnic groups in descending order of size were: $\tilde{Y}(1)_{\text{Group 1}} = 1.18$, $\tilde{Y}(1)_{\text{Group 2}} = 0.00$, $\tilde{Y}(1)_{\text{Group 3}} = -1.18$. The most significant differences in Simultaneous and Sequential Information Processing appear to be between the two Native groups. The Non-Native group takes an intermediate position between the two Native groups. The results of this ANOVA reinforces the suggestion that Ethnicity, as it reflects cultural experience, plays a major role in the development of the underlying construct of Simultaneous and Sequential Information Processing.

**Summary.**

A one-way ANOVA was carried out to corroborate the significant correlation between the Ethnicity dimension and the Simultaneous and Sequential Information Processing dimension of CA. Post-hoc analysis revealed statistically significant differences between all three Ethnic groups on mean scores on the Information Processing construct. These results confirm the conclusion reached earlier on Research Hypothesis 1, that it should be rejected in favour of maintaining that a relationship does exist between Ethnicity and Simultaneous and Sequential Information Processing.
Research Hypothesis 2.

There will be no statistically significant difference at the $\alpha = .05$ level on mean scores on a weighted linear composite of Simultaneous and Sequential Information Processing subtest tasks for Ethnicity, Age, Sex, and joint effects of these factors.

Statistical Hypothesis 2.

$H_0: R_{ci} = 0$ The canonical correlations between the two sets of variables, dependent and independent, for the population, will not be significantly correlated statistically at the $\alpha = .05$ level of significance.

Results of Testing the Statistical Hypothesis.

1. Canonical Analysis (CA):

A canonical correlation analysis was performed using BMDP6M (Dixon, 1981) between a set of grouping variables (Ethnicity, Age, and Sex) and a set of Simultaneous and Sequential Processing subtest variables (Hand Movements, Gestalt Closure, Number Recall, Triangles, Word Order, Matrix Analogies, Spatial Memory, and Photo Series). There were 5 age levels (8-12), 3 Ethnic groups (Non-Native, Village-Native, and City-Native children).

Assumptions. An examination of the assumption of normality basic to a canonical analysis was upheld: skewness and kurtosis of each independent variable was not excessive. The assumption of non-multicollinearity was upheld (see Table 9) since the multiple correlations of every variable in each set with all other variables in the same set was $\leq .51$. 

Table 9: Canonical Analysis: Test for Multicollinearity of Variables.

Squared Multiple Correlations of Each Variable in Set One with All Other Variables in Set One

<table>
<thead>
<tr>
<th>Variable</th>
<th>R-Squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethnicity</td>
<td>0.00</td>
</tr>
<tr>
<td>Age</td>
<td>0.00</td>
</tr>
<tr>
<td>Sex</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Squared Multiple Correlations of Each Variable in Set Two with All Other Variables in Set Two

<table>
<thead>
<tr>
<th>Variable</th>
<th>R-Squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand Movements</td>
<td>0.31</td>
</tr>
<tr>
<td>Gestalt Closure</td>
<td>0.29</td>
</tr>
<tr>
<td>Number Recall</td>
<td>0.47</td>
</tr>
<tr>
<td>Triangles</td>
<td>0.42</td>
</tr>
<tr>
<td>Word Order</td>
<td>0.51</td>
</tr>
<tr>
<td>Matrix Analogies</td>
<td>0.36</td>
</tr>
<tr>
<td>Spatial Memory</td>
<td>0.29</td>
</tr>
<tr>
<td>Photo Series</td>
<td>0.44</td>
</tr>
</tbody>
</table>

The plots in Figures 3 and 4 indicate that the assumption of a linear relationship between the first pair of canonical variates was reasonable. All standardized score values were within ±3.00 standard score units which indicated the absence of serious outliers. There was no missing data.

Results. The canonical correlation is contained in Table 10. The first canonical correlation was 0.67; the second was 0.43. The Chi-square tests for the first two canonical correlations were
Figure 3: Linearity of Relationship Between the First Canonical Variates.
Figure 4: Linearity of Relationship Between the Second Canonical Variates.
statistically significant: Chi-square (24) = 187.27, p < 0.00; and Chi-square (14) = 52.43, p < 0.00.

Table 10: Bartlett's Test for Significance of Eigenvalues

<table>
<thead>
<tr>
<th>Eigenvalue</th>
<th>Canonical Correlation</th>
<th>Chi-Square</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.45</td>
<td>Rc1 = 0.67</td>
<td>182.27</td>
<td>24</td>
<td>0.00</td>
</tr>
<tr>
<td>0.18</td>
<td>Rc2 = 0.43</td>
<td>52.43</td>
<td>14</td>
<td>0.00</td>
</tr>
</tbody>
</table>

The summary statistics for the canonical correlation analysis are provided in Table 11. The first two pairs of canonical variates \( \hat{Y}(1) \), \( \hat{X}(1) \), and \( \hat{Y}(2) \), \( \hat{X}(2) \) are contained in Column I and II respectively. The structure coefficients are contained in Column IA and IIA; the standardized canonical weights in Column IB and IIB.

The structure coefficients and standardized canonical weights indicate that the first dimension underlying the dependent variables is primarily a Simultaneous Processing dimension since the four highest structure coefficients were obtained by Simultaneous Processing subtests: Triangles = 0.78; Photo Series = 0.78; Matrix Analogies = 0.71; and Gestalt Closure = 0.70. Similarly, the first dimension underlying the independent variables is primarily an Age dimension (structure coefficient 0.86) with a moderate involvement of Ethnicity (structure coefficient 0.52). This would suggest that Simultaneous Processing is primarily a function of Age and that there are, very likely, significant differences between the three Ethnic groups.
Table 11: Summary Statistics for Canonical Correlation of Ethnicity, Age, and Sex with Simultaneous and Sequential Processing Subtests.

<table>
<thead>
<tr>
<th>Dependent Variable Set</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand Movements</td>
<td>0.55</td>
<td>0.09</td>
<td>0.57</td>
<td>0.68</td>
</tr>
<tr>
<td>Gestalt Closure</td>
<td>0.70</td>
<td>0.26</td>
<td>-0.23</td>
<td>-0.27</td>
</tr>
<tr>
<td>Number Recall</td>
<td>0.45</td>
<td>-0.10</td>
<td>0.14</td>
<td>0.09</td>
</tr>
<tr>
<td>Triangles</td>
<td>0.78</td>
<td>0.29</td>
<td>-0.08</td>
<td>-0.14</td>
</tr>
<tr>
<td>Word Order</td>
<td>0.62</td>
<td>0.23</td>
<td>0.19</td>
<td>0.09</td>
</tr>
<tr>
<td>Matrix Analogies</td>
<td>0.71</td>
<td>0.22</td>
<td>0.21</td>
<td>0.37</td>
</tr>
<tr>
<td>Spatial Memory</td>
<td>0.63</td>
<td>0.15</td>
<td>-0.53</td>
<td>-0.80</td>
</tr>
<tr>
<td>Photo Series</td>
<td>0.78</td>
<td>0.26</td>
<td>0.15</td>
<td>0.08</td>
</tr>
<tr>
<td>Percent of Variance</td>
<td>44%</td>
<td>10%</td>
<td>Total=54%</td>
<td></td>
</tr>
<tr>
<td>Redundancy Index</td>
<td>20%</td>
<td>02%</td>
<td>Total=22%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Independent Variable Set</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethnicity</td>
<td>0.52</td>
<td>0.52</td>
<td>0.82</td>
<td>0.81</td>
</tr>
<tr>
<td>Age</td>
<td>0.86</td>
<td>0.86</td>
<td>-0.51</td>
<td>-0.50</td>
</tr>
<tr>
<td>Sex</td>
<td>0.02</td>
<td>0.05</td>
<td>0.32</td>
<td>0.27</td>
</tr>
<tr>
<td>Percent of Variance</td>
<td>34%</td>
<td>34%</td>
<td>Total=68%</td>
<td></td>
</tr>
<tr>
<td>Redundancy Index</td>
<td>15%</td>
<td>06%</td>
<td>Total=21%</td>
<td></td>
</tr>
<tr>
<td>Canonical Correlation</td>
<td>0.67</td>
<td></td>
<td>0.43</td>
<td></td>
</tr>
<tr>
<td>Eigenvalue</td>
<td>0.45</td>
<td></td>
<td>0.18</td>
<td></td>
</tr>
</tbody>
</table>
The canonical analysis suggests a relatively strong relationship between the dependent and independent variables along the first dimensions \((R_{c1} = .67)\), and a marginal relationship between the dependent and independent variables along the second dimensions \((R_{c2} = .43)\).

The Percent of Variance indicates that the original \(Y\)-variables account for 44\% of the variance in the first canonical variate \(\hat{\text{Y}}(1)\), and 10\% of the variance in the second canonical variate \(\hat{\text{Y}}(2)\). This means that only 54\% of the variance in the first \(Y\)-composite is not accounted for by the four Simultaneous Processing Subtest variables (Triangles, Photo Series, Matrix Analogies, and Gestalt Closure), but that 90\% of the variance in the second \(Y\)-composite is not accounted for by the visual memory variables (Hand Movements and Spatial Memory).

The Redundancy Index indicates that for the first canonical variate \(\hat{\text{Y}}(1)\), 20\% of the variance is accounted for by the variables in the independent variable set (Ethnicity, Age, and Sex). However, for the second canonical variate \(\hat{\text{Y}}(2)\), only 2\% of the variance is accounted for by the variables in the independent variable set. This means that only 2\% of the variance on the Simultaneous and Sequential Processing Subtest set (for \(\hat{\text{Y}}(2)\)) is predictable from the linear combination of the independent variable set on the second canonical variate. For this reason there will be no further interpretation of the second canonical variate; only variates with a Redundancy Index of \(\geq 10\%\) will be considered for further interpretation.
An examination of the standardized coefficients indicates the relative order of importance of the variables on the first dimension underlying the first canonical pair \([\hat{X}(1), \hat{Y}(1)]\) was: Age (0.86), Ethnicity (0.52), and Sex (0.05). It is apparent that Age is the most important variable in the development of Simultaneous and Sequential Processing skills (as measured by the Simultaneous and Sequential Processing Subtests), but that Ethnic group membership does play a significant role in the development of these cognitive skills. Sex obviously has negligible influence in this developmental process.

**Summary.** The results of this canonical analysis led to a rejection of \(H_0\) since \(R_{11}\) was statistically significant at the .05 level. Both the pattern analysis and the structure coefficients from the canonical analysis suggest that the Simultaneous Processing Subtest (dependent) variables were almost equally weighted on the first linear composite of dependent variables, and that the Sequential Processing Subtest (dependent) variables were lower but almost equally weighted on the first linear composite of dependent variables. This was interpreted to mean that the Simultaneous Processing Subtests correlate more highly than the Sequential Processing Subtests with the underlying construct. This construct was interpreted to be a general cognitive construct having to do with information processing as measured by the Simultaneous and Sequential Processing Subtests.

The structure coefficients indicated that Age and Ethnicity demonstrated significant correlations (0.86 and 0.52 respectively) with
the latent construct underlying the independent variables. Therefore the construct was considered to be an Age/Ethnicity dimension with Age playing the major role in the relationship.

2. **ANOVA:**

An ANOVA was applied to the standardized scores on the first canonical variate, $\hat{Y}(1)$, as scores on a single dependent variable with Ethnicity and Age as the independent variables, since the canonical analysis suggested a significant correlation between these variables. The ANOVA design used was based on a two-way factorial model with three levels of the Ethnicity factor and five levels of the Age factor.

The results of this ANOVA confirms the canonical analysis by indicating a significant relationship between the latent construct underlying $\hat{Y}(1)$ and both Ethnicity and Age. Table 12 summarizes the results of the ANOVA.

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethnicity</td>
<td>27.06</td>
<td>2</td>
<td>13.53</td>
<td>24.49</td>
<td>0.00</td>
</tr>
<tr>
<td>Age</td>
<td>75.74</td>
<td>4</td>
<td>18.93</td>
<td>34.27</td>
<td>0.00</td>
</tr>
<tr>
<td>Interaction</td>
<td>5.16</td>
<td>8</td>
<td>0.65</td>
<td>1.17</td>
<td>0.32</td>
</tr>
<tr>
<td>Within</td>
<td>116.03</td>
<td>210</td>
<td>0.55</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
A graph for the cell means (in T-scores) for the ANOVA of the canonical variate scores, $Y(1)$, appears in Figure 5.

Figure 5: Cell Means on $Y(1)$, for Three Levels of Ethnicity and Five Levels of Age.

The graph in Figure 5 shows the main effects of Ethnicity and Age on the $Y(1)$ scores. Cell means at each level of Age with non-overlapping error bands are significantly different at the $\alpha = .05$ level. It is readily apparent that the Village-Native group is significantly different from the other two ethnic groups at every age level. Significant differences appear between the Non-Native and City-Native groups only at ages 9 and 11.

Trend analysis was applied to the cell means across Age for each Ethnic group (Glass & Hopkins, 1984). All three Ethnic groups display
linear trends: Village-Native, $F_{\text{linear}} = 4043.31$; Non-Native, $F_{\text{linear}} = 5446.51$; and the City-Native, $F_{\text{linear}} = 3816.15$. This would indicate a significant linear trend across Age in the $Y(1)$ scores for all three Ethnic groups.

**Summary.**

A two-way, factorial ANOVA was carried out to corroborate the significant correlation between the Ethnicity/Age dimension and the Simultaneous and Sequential Processing dimension. This relationship was more significant for the Simultaneous Processing Subtests, and understandably, for Age. However, of greater interest is the relationship between Simultaneous and Sequential Processing and Ethnic group membership.

Post-hoc analysis revealed statistically significant differences between the Village-Native group and the other two groups on mean scores on the Information Processing dimension at every age level. Significant differences between the Non-Native and City-Native groups are only evident at ages 9 and 11. There was no interaction effect.

These results further confirm the conclusion reached earlier on Research Hypothesis 2, that it should be rejected in favour of maintaining that a relationship does exist between Ethnicity, Age, and Simultaneous and Sequential Processing as measured by the Simultaneous and Sequential Processing Subtests.
Research Hypothesis 3.

There will be no statistically significant difference at the $\alpha = .05$ level between mean scores on a weighted linear composite of reading tasks for Ethnicity, Age, Sex, and joint effects of these factors.

Statistical Hypothesis 3.

$H_0: R_{CI} = 0$ The canonical correlations between the two sets of variables, dependent and independent, for the population, will not be significantly correlated statistically at the $\alpha = .05$ level of significance.

Results of Testing the Statistical Hypothesis.

1. Canonical Analysis (CA):

A canonical correlation analysis was performed using BMDP6M (Dixon, 1981) for a set of grouping variables (Ethnicity, Age, and Sex) and a set of reading variables (Word Identification, Passage Comprehension, and Reading Understanding). There were 5 Age levels (8-12), three Ethnic groups (Non-Native, Village-Native, and City-Native children), and 2 levels of Sex.

Assumptions. An examination of the assumption of normality basic to a canonical analysis was upheld: skewness and kurtosis of each dependent variable was not excessive. The assumption of non-multicollinearity was upheld (see Table 13) since the multiple correlations of every variable in each set with all other variables in the same set was ≤ .78. The plots in Figures 6 and 7 indicate that the assumption of a linear relationship between the first and second pairs of
Figure 6: Linearity of Relationship Between the First Canonical Variates.
Figure 7: Linearity of Relationship Between the Second Canonical Variates.
canonical variates, was reasonable. All standardized score values were within ±3.00 standard score units which indicated the absence of serious outliers. There was no missing data.

Table 13: Canonical Analysis: Test for Multicollinearity of Variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>R-Squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethnicity</td>
<td>0.00</td>
</tr>
<tr>
<td>Age</td>
<td>0.00</td>
</tr>
<tr>
<td>Sex</td>
<td>0.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th>R-Squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Word Identification</td>
<td>0.76</td>
</tr>
<tr>
<td>Passage Comprehension</td>
<td>0.76</td>
</tr>
<tr>
<td>Reading Understanding</td>
<td>0.78</td>
</tr>
</tbody>
</table>

Results. The canonical correlation and the results of the Chi-square test for statistical significance of the canonical correlations are contained in Table 14. The first canonical correlation was 0.72 and the second was 0.33. The Chi-square tests for the first two canonical correlations were statistically significant: Chi-square (9) = 187.28, p < 0.01; and Chi-square (4) = 26.31, p < 0.001.
Table 14: Bartlett's Test for Significance of Eigenvalues.

<table>
<thead>
<tr>
<th>Eigenvalue</th>
<th>Canonical Correlation</th>
<th>Chi-Square</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.52</td>
<td>Rc1 = 0.72</td>
<td>187.28</td>
<td>9</td>
<td>0.00</td>
</tr>
<tr>
<td>0.11</td>
<td>Rc2 = 0.33</td>
<td>26.31</td>
<td>4</td>
<td>0.00</td>
</tr>
</tbody>
</table>

The summary statistics for the canonical correlation analysis are provided in Table 15. The first two pairs of canonical variates $\hat{Y}(1), \hat{X}(1)$, and $\hat{Y}(2), \hat{X}(2)$, are contained in Columns I and II respectively. The structure coefficients are contained in Columns IA and IIA; the standardized canonical weights in Column IB and IIB.

The structure coefficients and standardized canonical weights, presented in Columns IA and IB of Table 15 indicate that the first dimension underlying the dependent variables is a Reading dimension (although Reading Understanding does make a slightly greater contribution to this dimension) with structure coefficients of 0.99 (Reading Understanding), 0.91 (Passage Comprehension), and 0.90 (Word Identification). Similarly, the first dimension underlying the independent variables is primarily an Age dimension (structure coefficient 0.84) with a moderate involvement of Ethnicity (structure coefficient 0.54). This would suggest that Reading is primarily a function of Age, but that Ethnic group membership is relevant to Reading competence (and especially to Reading Understanding). The canonical analysis suggests a strong relationship between the dependent and
Table 15: Summary Statistics for Canonical Correlation of Ethnicity, Age, and Sex with the Reading Subtests.

<table>
<thead>
<tr>
<th></th>
<th>First Canonical Variate</th>
<th>Second Canonical Variate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[Y(1)]</td>
<td>[Y(2)]</td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td><strong>Structure Coefficients</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Standardized Coefficients</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Dependent Variable Set</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Word Identification</td>
<td>0.90</td>
<td>0.16</td>
</tr>
<tr>
<td>Passage Comprehension</td>
<td>0.91</td>
<td>0.22</td>
</tr>
<tr>
<td>Reading Understanding</td>
<td>0.99</td>
<td>0.66</td>
</tr>
<tr>
<td>Percent of Variance</td>
<td>87%</td>
<td>06%</td>
</tr>
<tr>
<td>Redundancy Index</td>
<td>45%</td>
<td>01%</td>
</tr>
<tr>
<td><strong>Independent Variable Set</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethnicity</td>
<td>0.54</td>
<td>0.54</td>
</tr>
<tr>
<td>Age</td>
<td>0.84</td>
<td>0.84</td>
</tr>
<tr>
<td>Sex</td>
<td>0.06</td>
<td>0.09</td>
</tr>
<tr>
<td>Percent of Variance</td>
<td>33%</td>
<td>33%</td>
</tr>
<tr>
<td>Redundancy Index</td>
<td>17%</td>
<td>04%</td>
</tr>
<tr>
<td>Canonical Correlation</td>
<td>0.72</td>
<td></td>
</tr>
<tr>
<td>Eigenvalue</td>
<td>0.52</td>
<td></td>
</tr>
</tbody>
</table>

\[ \hat{X}(1) \] \hspace{1cm} \[ \hat{X}(2) \]
independent variables along the first dimension ($R_{c1} = 0.72$), and a weak relationship along the second dimension ($R_{c2} = 0.33$).

The Percentage of Variance indicates that the original $Y$-variables account for 84% of the variance in the first canonical variate ($\hat{Y}(1)$). This means that only 16% of the variance in the first $Y$-composite is not accounted for by the three Reading variables. Similarly, the original $X$-variables account for 33% of the variance in the first canonical variate ($\hat{X}(1)$), and 33% of the variance in the second canonical variate ($\hat{X}(2)$).

The Redundancy Index indicates that for the first canonical variate ($\hat{Y}(1)$), 45% of the variance is accounted for by the variables in the independent variable set (Ethnicity, Age, and Sex). However, for the second canonical variate ($\hat{Y}(2)$), only 1% of the variance is accounted for by the variables in the independent variable set. This means that only 1% of the variance on the Reading set [for $\hat{Y}(2)$] is predictable from the linear combination of the independent variable set on the second canonical variate. For this reason there will be no further interpretation of the second canonical variate as only variates with a Redundancy Index of ≥10% were considered for further interpretation.

An examination of the Standardized Coefficients (Columns IB, IIb) indicates the relative order of importance of the variables on the first dimension underlying the first pair of canonical variates ($\hat{X}(1), \hat{Y}(1)$) was: Reading Understanding (0.66), Passage Comprehension (0.22), and Word Identification (0.16), with the second members of the first pair being Age (0.84), Ethnicity (0.54), and Sex (0.09). While the development of
Reading Understanding (comprehension) skills is primarily determined by Age, the influence of Ethnic group membership is statistically significant. Sex obviously has little influence on the development of reading skills.

**Summary.** The results of this canonical led to a rejection of Ho since Rc1 and Rc2 were significant at the .05 level. Both the pattern analysis and the structure coefficients from the canonical analysis suggest that the Reading variables were almost equally weighted on the first linear composite of dependent variables. This was interpreted to mean that all three of the Reading Subtest variables correlate highly with the underlying construct (although Reading Understanding does display a slightly higher correlation). This construct was interpreted to be a general cognitive construct having to do with the development of reading skills as measured by the Word Identification, Passage Comprehension, and Reading Understanding Subtests.

The structure coefficients indicated that Age and Ethnicity demonstrate significant correlations (0.84 and 0.54 respectively) with the latent construct underlying the independent variables. Therefore the construct was considered to be an Age/Ethnicity dimension with Age playing the major role in the relationship.
2. **ANOVA:**

An ANOVA was applied to the standardized scores on the first canonical variate, $\hat{Y}(1)$, as scores on a single dependent variable with Ethnicity and Age as the independent variables, since the canonical analysis suggested a significant correlation between these variables. The ANOVA design used was based on a two-way, fixed-effects model with three levels of the Ethnicity factor and five levels of the Age factor.

The results of this ANOVA confirms the canonical analysis by indicating a significant relationship between the latent construct underlying $\hat{Y}(1)$ and both Ethnicity and Age. There was no Ethnicity/Age interaction. Table 16 summarizes the results of the ANOVA.

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethnicity</td>
<td>34.55</td>
<td>2</td>
<td>17.28</td>
<td>0.00</td>
</tr>
<tr>
<td>Age</td>
<td>84.30</td>
<td>4</td>
<td>21.08</td>
<td>0.00</td>
</tr>
<tr>
<td>Interaction</td>
<td>6.42</td>
<td>8</td>
<td>0.80</td>
<td>0.10</td>
</tr>
<tr>
<td>Within</td>
<td>98.72</td>
<td>210</td>
<td>0.47</td>
<td></td>
</tr>
</tbody>
</table>

A graph for the cell means (in T-scores) for the ANOVA of the Canonical Variate Scores, $\hat{Y}(1)$, appears in Figure 8.
The graph in Figure 8 shows the main effects of Ethnicity and Age on the \( \hat{Y}(1) \) scores. Cell means at each level of Age with non-overlapping bands are significantly different at the \( \alpha = .05 \) level (Glass & Hopkins, 1984). The graph indicates that while all three Ethnic groups begin at age 8 with very similar \( \hat{Y}(1) \) mean scores, significant differences between the Ethnic groups appear at most of the Age levels with the exception of no difference between the Non-Native and City-Native groups at ages 10 and 11. The difference between the two Native groups is most apparent from ages 8-12.

Trend analysis was applied to the cell means across Age for each Ethnic group (Glass & Hopkins, 1984). All three Ethnic groups display
linear trends: Village-Native, F(linear) = 4418.20; Non-Native, F(linear) = 7347.13; and the City-Native, F(linear) = 5495.59. This would indicate a significant linear trend across Age in the Y(1) scores for all three Ethnic groups.

The effects of both factors are statistically significant, overall. The graph of the cell means shows a substantial linear trend with Age and separation of trend lines with Ethnicity.

Taken together, the results of the ANOVA and the post-hoc comparisons would suggest that the Village-Native children were significantly different in the acquisition of Reading skills (from ages 8-12) than the other two Ethnic groups. Both City-Native and Non-Native children were very similar in their development of Reading skills from ages 8-12, with the only significant difference between these two Ethnic groups at ages 9 (which may be an artifact of the City-Native sample at this age level) and 12.

Summary.

A two-way ANOVA was carried out to corroborate the significant correlations between the Ethnicity/Age dimension and the Reading dimension from the canonical correlation. This relationship was highly significant for the Reading Subtests (Word Identification, Passage Comprehension, and Reading Understanding). The first dimension along the independent variable set was highly significant for Age and moderately significant for Ethnicity. There was no statistically significant interaction effect.
Post-hoc analysis revealed statistically significant differences between the two Native groups for the Y(1) ANOVA, with the Village-Native group displaying a developmental pattern quite distinct from the other two Ethnic groups from ages 9-12. The differences between the two Native groups was most apparent with the City-Native group most resembling the Non-Native group. These results further confirm the conclusion reached earlier on Research Hypothesis 3, that it should be rejected in favour of maintaining that a relationship does exist between Ethnicity and Reading as measured by Word Identification, Passage Comprehension, and Reading Understanding Subtests.
Research Hypothesis 4.

There will be no statistically significant difference at the $\alpha = .05$ level between mean scores on a weighted linear composite of neurological maturation tasks for Ethnicity, Age, Sex, and joint effects of these factors.

Statistical Hypothesis 4.

$H_0: R_{ci} = 0$ The canonical correlations between the two sets of variables, dependent and independent, for the population, will not be significantly correlated statistically at the $\alpha = .05$ level of significance.

Results of Testing the Statistical Hypothesis.

1. Canonical Analysis (CA):

A canonical correlation analysis was performed using BMDP6M (Dixon, 1981) between a set of grouping variables (Ethnicity, Age, and Sex) and a set of neurological maturation variables (Grip Strength Dominant hand and Grip Strength Other hand). There were 5 age levels (8-12), and three Ethnic groups (Non-Native, Village-Native, and City-Native children), and 2 levels of Sex.

Assumptions. An examination of the assumption of normality basic to a canonical analysis was upheld: skewness and kurtosis of each dependent variable was not excessive. The assumption of non-multicollinearity was upheld (see Table17) as the multiple correlations of every variable in each set with all other variables in the same set was $\leq .82$. The plot in Figure 9 indicates that the assumption of
Figure 9: Linearity of Relationship Between the First Canonical Variates.
a linear relationship between the first pair of canonical variates, was reasonable. All standardized score values were within ±3.00 standard score units which indicated the absence of serious outliers.

Table 17: Canonical Analysis: Test for Multicollinearity of Variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>R-Squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grip Strength Dominant hand</td>
<td>0.82</td>
</tr>
<tr>
<td>Grip Strength Other hand</td>
<td>0.82</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th>R-Squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethnicity</td>
<td>0.00</td>
</tr>
<tr>
<td>Age</td>
<td>0.00</td>
</tr>
<tr>
<td>Sex</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Results. The canonical correlation and the results of the Chi-square test for statistical significance are contained in Table 18. The first canonical correlation was 0.61. The Chi-square test for the first canonical correlation was statistically significant: Chi-square (6) = 105.71, p < 0.00.
Table 18: Bartlett’s Test for Significance of Eigenvalues.

<table>
<thead>
<tr>
<th>Eigenvalue</th>
<th>Canonical Chi-Square</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.38</td>
<td>Rc1 = 0.61</td>
<td>6</td>
<td>0.00</td>
</tr>
</tbody>
</table>

The summary statistics for the canonical correlation analysis are provided in Table 19. The first pair of canonical variates \(\hat{Y}(1)\) and \(\hat{X}(1)\) are contained in Column I. The structure coefficients are contained in Column IA; the standardized canonical weights in Column IB.

The structure coefficients and standardized canonical weights indicate that the first dimension underlying the dependent variables is a Grip Strength dimension with structure coefficients of 0.99 and 0.86 for Grip Strength Dominant Hand and Grip Strength Other Hand respectively. Similarly, the first dimension underlying the independent variables is primarily an Age dimension (structure coefficient 0.93) with a minor involvement of Ethnicity (structure coefficient 0.34). This would suggest that Grip Strength (especially of the Dominant Hand) is a function of Age, but that there are modest Ethnic group differences.

The canonical analysis suggests a strong relationship between the dependent and independent variables along the first dimension (Rc1 = 0.61).
Table 19: Summary Statistics of Canonical Correlation of Ethnicity, Age, and Sex with Neurological Maturation.

<table>
<thead>
<tr>
<th>First Canonical Variate</th>
<th>([\hat{Y}(1)])</th>
<th>([\hat{X}(1)])</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A)</td>
<td>(B)</td>
<td></td>
</tr>
<tr>
<td>Structure Coefficients</td>
<td>Standardized Coefficients</td>
<td></td>
</tr>
<tr>
<td>Grip Strength Dominant Hand</td>
<td>0.99</td>
<td>1.21</td>
</tr>
<tr>
<td>Grip Strength Other Hand</td>
<td>0.86</td>
<td>-0.23</td>
</tr>
<tr>
<td>Percentage of Variance</td>
<td>86%</td>
<td>33%</td>
</tr>
<tr>
<td>Redundancy Index</td>
<td>33%</td>
<td>13%</td>
</tr>
</tbody>
</table>

Independent Variable Set

| Ethnicity | 0.34 | 0.34 |
| Age      | 0.93 | 0.92 |
| Sex      | -0.20 | -0.17 |

| Percentage of Variance | 34\% |
| Redundancy Index       | 13\% |

Canonical Correlation | 0.61 |
Eigenvalue             | 0.38 |
The Percentage of Variance indicates that the original Y-variables account for 86% of the variance in the first canonical variate \( Y(1) \). This means that only 14% of the variance in the first Y-composite is not accounted for by the two Neurological variables.

An examination of the standardized coefficients (Column IB) indicates the relative order of importance of the variables on the underlying dimension, for the first set was: Grip Strength Dominant Hand (1.21), and Grip Strength Other Hand (-0.23); and for the second set was: Age (0.92), Ethnicity (0.34), and Sex (-0.17).

Both the structure coefficients and the pattern analysis of the standardized weights suggest that Age (and to a modest degree, Ethnicity) is related to Grip Strength (especially of the Dominant Hand).

**Summary.** The results of this canonical analysis led to a rejection of Ho since \( R_c1 \) was statistically significant at the .05 level. The structure coefficients from the canonical analysis suggest that the Neurological Maturation subtest variables were almost equally weighted on the first composite of dependent variables. This was interpreted to mean that both Grip Strength Dominant Hand and Grip Strength Other Hand correlate highly with the underlying construct. The construct was seen as a general cognitive construct having to do with Neurological Maturation. On the other hand, both the pattern analysis and the structure coefficients indicated that only Age correlated highly with the latent construct underlying the independent variables; Ethnicity
exhibited a low correlation with the construct. Accordingly, the construct was seen as an Age dimension. To summarize: Research Hypothesis 4 was rejected in favour of the conclusion that Age is significantly correlated with the cognitive construct of Neurological Maturation.

2. **ANOVA:**

   An ANOVA was applied to the standardized scores on the first canonical variate, $\hat{Y}(1)$, as scores on a single dependent variable with Ethnicity and Age as the independent variables, since the canonical analysis suggested a significant correlation between these variables. The ANOVA design used was based on a two-way, fixed-effects model with three levels of the Ethnicity factor and five levels of the Age factor.

   The results of this ANOVA confirms the canonical analysis by indicating a significant relationship between the latent construct underlying $\hat{Y}(1)$ and both Age and Ethnicity. There was no statistically significant interaction effect. Table 20 summarizes the results of the ANOVA.
Table 20: ANOVA for Canonical Variate Scores, $\hat{Y}(1)$, for Three Levels of Ethnicity and Five Levels of Age.

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethnicity</td>
<td>25.68</td>
<td>2</td>
<td>12.84</td>
<td>472.50</td>
<td>0.00</td>
</tr>
<tr>
<td>Age</td>
<td>192.27</td>
<td>4</td>
<td>48.07</td>
<td>1768.52</td>
<td>0.00</td>
</tr>
<tr>
<td>Interaction</td>
<td>0.29</td>
<td>8</td>
<td>0.04</td>
<td>1.36</td>
<td>0.21</td>
</tr>
<tr>
<td>Within</td>
<td>5.71</td>
<td>210</td>
<td>0.03</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A graph for the cell means (in T-scores) for the canonical variate scores, $\hat{Y}(1)$, for three levels of Ethnicity and five levels of Age, taken from the ANOVA of Table 20, appears in Figure 10.

Figure 10: Cell Means of ANOVA of Canonical Variate T-Scores on $\hat{Y}(1)$, for Three Levels of Ethnicity and Five Levels of Age.
The graph in Figure 10 illustrates the main effects of Ethnicity and Age on the $\hat{Y}(1)$ scores. Cell means at each level of Age with non-overlapping error bands are significantly different at the $\alpha = .05$ level (Glass & Hopkins, 1984). Significant differences are apparent between all three Ethnic groups at every Age level.

Trend analysis was applied to the cell means across Age for each Ethnic group (Glass & Hopkins, 1984). All three Ethnic groups display linear trends: the Village-Native, $F(\text{linear}) = 225,337.81$; Non-Native, $F(\text{linear}) = 213,445.27$; and the City-Native, $F(\text{linear}) = 199,347.76$. This would indicate a significant linear trend across Age in the $\hat{Y}(1)$ scores for all three Ethnic groups.

The effects of both factors are statistically significant, overall. The graph of the cell means shows a substantial linear trend with Age and separation of the trend lines with Ethnicity.

**Summary.**

A two-way, fixed-effects ANOVA was carried out to corroborate the significant correlation between the Ethnicity/Age dimension and the Neurological Maturation dimension. This relationship was slightly more significant for the Grip Strength Dominant Hand subtest, and understandably, for Age. There was no interaction effect. These results further confirm the conclusion reached earlier on Research Hypothesis 4, that is should be rejected in favour of maintaining that a relationship does exist between Ethnicity and Neurological Maturation as measured by the Grip Strength subtests. However, the relationship between Age and Grip Strength is of much greater significance.
Summary of the Research Hypotheses.

The purpose of the study was to investigate the relationships between the independent variables, Ethnicity, Age, and Sex, and the dependent variables, Simultaneous and Sequential Processing, the Simultaneous and Sequential Processing Subtests, the Reading Subtests, and the Neurological Maturation Subtests.

Four Research Hypotheses were stated, each one proposing no statistically significant effects at the $\alpha = 0.05$ level on mean scores on a weighted linear composite of the dependent variable set for the independent variable set (Ethnicity, Age, Sex), and joint effects of these factors. All four Research Hypotheses were rejected at the $\alpha = 0.05$ level.

Research Hypothesis 1: indicated that a relationship does exist between Ethnicity and Simultaneous and Sequential Processing. Post-hoc comparison of means indicated statistically significant differences between the three Ethnic groups.

Research Hypothesis 2: indicated that a relationship does exist between Ethnicity and Age and the Simultaneous and Sequential Processing Subtests (although this relationship was more significant for Simultaneous Processing and Age). There was no statistically significant interaction effect. The Village-Native group was significantly different to the two other Ethnic groups at every Age level.
Research Hypothesis 3: indicated that a relationship does exist between Ethnicity and Age and the Reading Subtests. This relationship is highly significant for Age and moderately significant for Ethnicity. There was no statistically significant interaction effect. The Village-Native group was significantly different from the other two Ethnic groups.

Research Hypothesis 4: indicated that a relationship does exist between Ethnicity and Age and Neurological Maturation. This relationship is highly significant for Age. There was no statistically significant interaction effect. There was a substantial linear trend with Age and separation of trend lines with Ethnicity.
CHAPTER V DISCUSSION, SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This chapter will begin with a restatement of the Purpose of the Study. This will be followed by a Discussion section which will present each Research Hypothesis with supporting evidence, a discussion of the Instrumentation used in the study, followed by a General Discussion of issues relevant to the Research Hypotheses. The Summary section will be contained in the consideration of two issues of concern to educators that are central to the purpose of the study:

1. Do Native Indian children have a unique/habitual Information Processing style?
2. Is the K-ABC Simultaneous and Sequential Information Processing model useful in the remediation of deficiencies in the academic achievement of Native Indian children?

This will be followed by the Conclusions, and Recommendations for Further Research.

Purpose of the Study.

The purpose of this study was to determine if cultural group differences exist in the developmental patterns of Information Processing, Reading, and Neurological Maturation. The K-ABC Simultaneous and Sequential Processing model was used to measure the developmental trends of Information Processing of Non-Native, City-Native, and Village-Native children ages 8-12. Reading was measured by the B.C. QUIET Achievement Test: Word Identification and Passage Comprehension Subtests, and the K-ABC: Reading Understanding Subtest; Neurological Maturation by the Grip Strength Test.
Discussion

Research Hypotheses:

This section will discuss the four Research Hypotheses in view of the evidence gained from analysis of the data.

Research Hypothesis 1.

There will be no statistically significant effects at the $\alpha = .05$ level on mean scores on a weighted linear composite of Simultaneous and Sequential Information Processing tasks for Ethnicity, Age, and Sex, and joint effects of these factors.

The results of the canonical analysis led to a rejection of Research Hypothesis 1 as RC1 was statistically significant at the .05 level. Ethnicity correlated highly with the underlying construct of Information Processing. ANOVA corroborated the correlation between the Ethnicity dimension and the Simultaneous and Sequential Processing dimension of CA. Post-hoc analysis revealed significant differences between all three Ethnic groups on mean scores on the Information Processing construct with the most significant differences being between the two Native groups. This would suggest that Ethnicity, which must be interpreted as cultural/environmental experience, plays a major role in the development of Simultaneous and Sequential Information Processing ability. This means that differences in the achievement of Native Indian children are a function of cultural/experiential background rather than the mere fact that they are Native Indian.
Research Hypothesis 2.

There will be no statistically significant effects at the $\alpha = .05$ level on mean scores on a weighted linear composite of Simultaneous and Sequential Information Processing Subtest tasks for Ethnicity, Age, Sex, and joint effects of these factors.

The results of the canonical analysis led to a rejection of Research Hypothesis 2 as RC1 was statistically significant at the .05 level. Both Age and Ethnicity were significantly correlated with the construct underlying the Simultaneous and Sequential Information Processing Subtests. ANOVA corroborated the results of the CA; there was no statistically significant interaction effect. Post-hoc analysis revealed statistically significant differences between the Village-Native group and the other two Ethnic groups on mean scores on the Information Processing dimension at every Age level. There was a significant linear trend across Age for all three Ethnic groups. The results of this analysis further supports the suggestion that Ethnicity plays a significant role in the development of Information Processing abilities.

Research Hypothesis 3.

There will be no statistically significant effects at the $\alpha = .05$ level between mean scores on a weighted linear composite of Reading tasks for Ethnicity, Age, Sex, and joint effects of these factors.

The results of the canonical analysis led to a rejection of Research Hypothesis 3 as RC1 was statistically significant at the .05 level. Both Age and Ethnicity demonstrated significant correlations with the
construct underlying the Reading variable set although Age did play the major role in this relationship. ANOVA confirmed the results of the CA; there was no statistically significant interaction effect. Post-hoc analysis revealed statistically significant differences between the two Native groups on mean scores on the Reading construct.

**Research Hypothesis 4.**

There will be no statistically significant effects at the $\alpha = .05$ level between mean scores on a weighted linear composite of Neurological Maturation tasks for Ethnicity, Age, Sex, and joint effects of these factors.

The results of the canonical analysis led to a rejection of Research Hypothesis 4 as RC1 was statistically significant at the .05 level. Age correlated highly with the underlying construct of Neurological Maturation. ANOVA confirmed the results of the CA by indicating a significant relationship between the latent construct underlying the Neurological Maturation dimension and both Age and Ethnicity. There was no statistically significant interaction effect. Post-hoc analysis revealed significant differences between all three Ethnic groups at every Age level with significant linear trends across Age. While the results of this CA does reveal a significant relationship between Age and Neurological Maturation, of greater interest is the relationship between Ethnicity and Neurological Maturation.

**Summary.**

The results of Research Hypotheses 1-4 support the purpose of
the study in suggesting that there are significant differences in Simultaneous and Sequential Processing, Reading, and Neurological Maturation between the Ethnic and Age groups. Differences between the Sexes were non-significant.

Of greater interest was the consistent pattern of significant differences between the two Native Indian groups, and the similarity of the City-Native group to the Non-Native group. Post-hoc analysis indicated that Age trends for Research Hypotheses 2-4 were linear for all three Ethnic groups. There were no statistically significant interaction effects.

These findings support the suggestion that cultural/environmental experience, as measured by Ethnicity, plays a major role in the development of Information Processing, Reading, and Neurological Maturation.

Instrumentation.

The K-ABC: Mental Processing Scale

The K-ABC Mental Processing Scale was used to measure the Simultaneous and Sequential Information Processing abilities of children in the three Ethnic groups across an 8-12 age range. It was anticipated, on the basis of previous findings in the literature, that Native Indian children would display a lag in the development of Sequential Processing and that this could be proposed as one of the reasons why Native children
experience difficulties with academic achievement i.e. reading.

The results of this study would suggest that both modes of Information Processing are available to the Native or Non-Native child at different ages and that Simultaneous and Sequential Processing do not appear to exhibit consistent differential maturational trends across the age range of the study. This is consistent with Kaufman & Kaufman's (1983c) claim that both Sequential and Simultaneous Processing appear to correlate equally well with various measures of reading.

The group that came closest to displaying a lag in the development of Sequential Processing as compared to Simultaneous Processing was the Non-Native group. Simultaneous Processing appeared to be the stronger form of processing for Non-Native children at every age level except age 9 and this difference increased as these children got older. The City-Native group exhibited virtually identical Simultaneous and Sequential Processing skills at age 8 with a decline in both modes through to age 12. An initial lag in the development of Sequential Processing skills for City-Native children is not evident nor is the overall superiority of Simultaneous versus Sequential Processing. The Village-Native group exhibited considerable similarity in the developmental trends for Simultaneous and Sequential Processing throughout the age range with Simultaneous Processing significantly higher than Sequential Processing at age 10. It appears that only from ages 8-9 is Sequential Processing the predominant mode of information processing for Village-Native children.
It can be concluded that consistent differences in the developmental patterns for Simultaneous and Sequential Processing for each Ethnic group were not evident. The results of this study did not indicate that one form of Mental Processing develops earlier than the other.

While it would perhaps be convenient to suggest that the developmental patterns of Simultaneous and Sequential Processing are similar for all three cultural groups, this was not supported by the results of the study. It was evident that differences in Simultaneous and Sequential Processing between the two Native groups were more evident than differences between the Non-Native and Native groups. The results of CA for Research Hypotheses 1-2 indicated that there is a statistically significant relationship between Ethnicity and Simultaneous and Sequential Processing. Post-hoc analysis indicated statistically significant differences between the three Ethnic groups with the Village-Native group significantly different than the City-Native group. The tendency of Simultaneous Processing to display a more significant relationship with Age may merely be a reflection of the higher level of complexity of the Simultaneous Processing Subtests. Thus there was no evidence of a "Native Indian pattern" of Simultaneous and Sequential Processing, but differences in Simultaneous and Sequential Processing based on cultural/experiential background as measured by Ethnicity.

This would suggest that cultural experience, as measured by Ethnicity, and not ethnic group membership is the primary influence on Simultaneous and Sequential Processing. What is evident is a different
maturational rate of Information Processing skills in the Village-Native group. It should be stressed that these children are still developing intellectually when compared to themselves, and often at the same rate as the environmentally different City-Native and Non-Native children. Experience, then, must be seen as a major determinant of Information Processing ability and must be taken into account in any attempt to compare Native and Non-Native children.

The Reading Subtests: Word Identification, Passage Comprehension, and Reading Understanding.

While Word Identification and Passage Comprehension are B.C. QUIET Subtests and Reading Understanding a K-ABC Subtest, all three of these reading tests exhibited very similar relationships to the independent variables Ethnicity and Age. The structure coefficients for Word Identification and Passage Comprehension on the CA were 0.90 and 0.91 respectively, indicating virtually no difference in the ability of either B.C. QUIET Subtest to measure the construct underlying the dependent variable set (Reading). This would suggest that a measure of reading decoding would be as effective a measure of reading skills as a measure of reading comprehension using the contextual clues provided by a cloze procedure.

While the relationship between the reading dimension and Age on the CA was not unexpected, of greater interest was the moderate but statistically significant relationship between Ethnicity and the Reading Subtests. Post-hoc analysis revealed significant differences between the Village-Native group and the other two Ethnic groups. The
development of reading skills, over an 8-12 age range, does not follow the same pattern for Village-Native children as it does for Non-Native or City-Native children. This would suggest that cultural/experiential background may play as important a role in the development of reading competence as instructional programs and materials.

Neurological Maturation: Grip Strength Dominant Hand and Grip Strength Other Hand.

The Grip Strength Test was used as a measure of Neurological Maturation. CA revealed a high correlation between the construct underlying the Neurological Maturation dimension and Age, a not unexpected finding. Of greater interest is the significant relationship between Ethnicity and Neurological Maturation. The trend lines for Neurological Maturation were linear for Age and were significantly separated for Ethnicity. This would suggest that maturational patterns may not be the same for children in distinctly different cultural/environmental settings. Attempts to design instructional programs should take into account these differences in maturation which might influence a child's readiness for instruction.
General Discussion.

The general discussion of this study will be contained in the consideration of two issues of educational significance that are central to the purpose of the study:

1. Do Native Indian children have a unique/habitual Information Processing style?

2. Is the K-ABC Simultaneous and Sequential Processing model useful in the remediation of deficiencies in the academic achievement of Native Indian children?

Do Native Indian Children Have a Unique/Habitual Information Processing Style?

Berry (1966) argued that ecological demands lead to the development of certain perceptual skill patterns. What is uncertain is whether or not these skill patterns or perceptual preferences are permanent. Luria (1966a) also accepted this position, that our intellectual processes are determined by genetic/ethnic factors and by exposure to cultural and environmental experiences. While the data from this study would support such a view, it would also suggest that as cultural and environmental experiences are changed, so are the intellectual and academic outcomes.

If Native children rely more on the visual than on the verbal (Guilmet, 1979; Phelps, 1972) and if they truly have a visual learning style (Kaulback, 1984), we would expect that they would exhibit strengths in
Simultaneous Processing when compared to Non-Native children. This was not evident in this study as the most significant differences in Simultaneous Processing were between the Village-Native and City-Native groups. There was no "Native Indian pattern" of Simultaneous Processing. Differences between the two Native groups on Sequential Processing were also greater than differences between either Native group and the Non-Native group.

The "old way" may have involved observation or visual-experiential learning, but in what was probably a visually consistent environment. The "new way" facing the City-Native children involves verbal and visual learning in a stimulating and constantly changing environment which maximizes the need for visual and language skills. Awareness of the environment is also a "survival" skill in the city. The pattern of highly acute visual skills in children living a more traditional lifestyle (Kleinfield, 1970) was not evident in the Village-Native children. It is doubtful that the Village-Native child would receive any more practice in dealing with complex visual patterns than the City-Native child. Differences between the Village-Native and City-Native children are probably not so much related to "enriched conditions for visual learning" in the village communities as they are to different economic conditions that perhaps have considerable impact on cognitive and linguistic development and on the child's curiosity (Nerlove & Snipper, 1981; Downing et al., 1975).

While cultural differences in memory have been reported (Kearins, 1981; Meacham, 1975) and are very specific (Sternberg, 1982), there was
no evidence on the subtests that are the best measures of memory (Spatial Memory, Hand Movements, Number Recall, and Word Order) of a consistent Native pattern of memory skills. The Spatial Memory subtest was the only Simultaneous Processing subtest in which the Non-Native group displayed the highest mean scores (except at age 9). The developmental trends for the Non-Native and Village-Native groups on Spatial Memory were almost identical across the entire age range. On the Hand Movements subtest there is considerable similarity between the Non-Native and Village-Native groups with the City-Native group considerably higher in skill levels. All three groups display considerable similarity in skill levels on Number Recall but with slightly greater similarity between the Non-Native and Village-Native groups. The Word Order subtest produced virtually identical trends for the Non-Native and City-Native groups; the most significant differences were between the two Native groups.

This study has produced little evidence to support the claim of a "typical Native learning style." Instead it supports the view that differences in cognitive abilities, mental processing, or learning style are influenced by cultural/economic/experiential factors. Kaulback's (1984) contention "that many Native children, by virtue of their predisposition to a visual style of learning, may be handicapped by their ability to succeed in school because schools and teaching methods tend to cater to the auditory learner" (p. 35) does not appear to be supported by the results of this study.

Whether or not Native children perform better on non-verbal than on
verbal tests (MacArthur, 1962; Vernon, 1965) cannot be confirmed by this study as the verbal content of the K-ABC is concentrated in the Achievement Scale. It is possible that Village-Native children would display superior abilities on the Mental Processing Scale than on the Achievement Scale just as they do on the Performance versus the Verbal Scales of the WISC-R (Scaldwell, Frame & Cookson, 1984; McShane & Plas, 1984; Browne, 1984). It is not expected that there would be significant differences on the K-ABC Achievement Scale between City-Native and Non-Native children.

Future research efforts should concentrate on examining differences between Village-Native and City-Native children. Do the Village-Native children use a processing mode that favours the right hemisphere (Cohen, 1969) or are they, like most low SES children, merely exposed to less language enrichment, linguistic "readiness" experiences, etc? While there is no doubt that children can differ in their ability to learn when exposed to different types of input, this may not be true of entire cultural groups but rather of individuals within these groups. Thus we must remind ourselves that the Village-Native children exhibited developmental trends in Mental Processing that were often very similar, although somewhat lower, than the trends for the other two groups. Gains in skill levels, when compared to themselves, were often as noticable for the Village-Native children as for the Non-Native or City-Native children.

Naglieri et al., (1983) indicated that "normal and exceptional children...employ simultaneous and successive processes differently in
solving more complex tasks" (p. 32). Perhaps Village-Native children, as a consequence of their unique cultural/experiential circumstances must also be looked upon as exceptional children. The three most complex subtests in the Mental Processing Scale are undoubtedly Triangles, Matrix Analogies, and Photo Series. All three cultural groups are fairly consistent in developmental trends on the Triangles subtest with the most noticeable differences appearing between the two Native groups. A somewhat similar pattern is exhibited by the Matrix Analogies subtest where despite considerable variability between groups, at age 12 highly significant differences exist between the two Native groups. On the Photo Series subtest, the City-Native group most resembles the Non-Native group. While the Non-Native and Village-Native groups are very similar in Photo Series skills from ages 8-9, this is certainly not the case at ages 10-12. It appears that there may be more of a cumulative deficit for complex problem solving as Village-Native children approach the upper limits of the age range of this study.

A more detailed examination of this issue of subtest complexity is warranted in view of concerns about cultural group differences.

Jensen (1984) indicated that only the Triangles and Matrix Analogies subtests are even intermediate in complexity; the other Mental Processing subtests are to be seen as measuring rather simple behaviours. This evaluation of the Mental Processing Scale was shared by Bracken (1985) who indicated that only Triangles, Matrix Analogies, and Photo Series clearly require problem solving; the other subtests involve processing at an automatic level. The Word Order subtest can
perhaps be included in this group of more complex Mental Processing subtests as Word Order, Matrix Analogies, and Photo Series require the integration of Sequential and Simultaneous Processing and show the strongest relationships to external criteria of achievement. These subtests therefore demonstrate the highest g loadings as complexity determines g loading (Jensen, 1980; 1984). Spearman (1927) also suggested that g is related to complexity and to abstraction. We should therefore be able to examine cultural differences in these more complex mental processing subtests as Native/Non-Native differences in cognitive abilities, if they truly exist, should be directly related to g loadings. These differences:

On diverse mental tests appears to be chiefly a difference in the general factor common to all of the tests rather than a difference in the more specific sources of test score variances associated with any particular informational content, scholastic knowledge, specific acquired skills, or type of test. (Jensen, 1984, p. 26)

An examination of the Triangles subtest indicates virtually identical developmental patterns for the Non-Native and City-Native groups. While the overall trend for the Village-Native group is similar to the other two groups, the developmental level for Triangles is lower at every age level except age 12.

The Matrix Analogies subtest indicates greater variability in the developmental trends for the three cultural groups. The City-Native and Village-Native groups are similar in Matrix Analogies skills only at age 8 then exhibit marked and increasing differences in level and pattern of skill acquisition of this form of Simultaneous Processing. While somewhat
similar in Matrix Analogies skills to the City-Native group at age 8, the Non-Native group more resembles the Village-Native group from ages 9-11, then rapidly increases to the same skill level as the City-Native group at age 12. As in the case of the Triangles subtest, the Matrix Analogies subtest provides a distinct comparison between the two Native groups as these groups are statistically different at every age level except age 8.

On the Photo Series subtest, the most apparent differences were between the Village-Native and City-Native groups. While the Non-Native group is virtually identical in Photo Series skills to the Village-Native group from ages 8-9, this is not the case from ages 10-12 where the Non-Native group displays considerable overlap with the City-Native group. The pattern of skill development for the Village-Native group from ages 9-12 is distinct from the other two groups.

It appears that when we consider the most complex mental processing subtests (Triangles, Matrix Analogies, Photo Series, and to a lesser extent, Word Order), there is no distinct "Native Indian pattern" of mental processing. Rather, these subtests provide the most distinct comparisons between the two Native groups with the Village-Native group exhibiting consistently lower Mental Processing skill levels and increasing deficits across the age range of the study.

The Number Recall subtest, the purest measure of short-term memory in the Mental Processing Scale, should also display cross-cultural differences (as Jensen & Reynolds, 1982, have indicated that black
children, another economically/culturally "disadvantaged" minority, score higher than white children on short-term memory on the WISC-R). However, the K-ABC Interpretive Manual (p. 42) indicates that Number Recall was selected for the Mental Processing Scale because in previous studies it has been found to yield no significant differences between blacks and whites when SES is controlled. An examination of the developmental trends for the Number Recall subtest indicates virtually identical skill levels for all three cultural groups at ages 8, 10, and 12; noticeable differences between the Village-Native and City-Native groups at ages 9 and 11; and noticeable differences between the Non-Native and City-Native groups at ages 9 and 11. It appears that there is, once again, no consistent "Native Indian pattern" of short-term memory skills. There also appears to be considerable similarity in short-term memory skills, as measured by the Number Recall subtest, between the three groups, particularly at ages 8, 10, and 12.

The Simultaneous and Sequential Processing model involves the assumption that both forms of processing are available to the child at any given time. The decision as to which form of processing to use depends upon cultural/genetic factors, the individual's preferred style of processing, and characteristics of the task itself (Das et al, 1975). The idea that individuals have preferred modes of information processing was not explicitly mentioned in Luria's theory of cognitive function (Goetz & Hall, 1984). The data from this study does not support the suggestion that Native children do not choose Sequential Processing because it is not the preferred mode of information processing in their culture.
Despite Kaufman & Kaufman's (1983c) insistence on defining intelligence "in terms of an individual's style of solving problems and processing information" (p. 2), we need to remember that because the K-ABC Simultaneous and Sequential Processing subtests are not pure measures of these processes (Goetz & Hall, 1984), which the Kaufmans admit in the Interpretive Manual (1983c, p. 31), that they cannot tell us what we need to know about a child's problem solving abilities and strategies. Cognitive abilities, strategies, and planning functions not measured by the K-ABC may indeed have a significant impact on a child's performance on the Simultaneous or Sequential Processing Scales. Certainly there can be inter- and intra-cultural differences in these factors that are not measured by the K-ABC.

One might question whether further investigations of the "unique perceptual abilities" of Native children (Havighurst, 1970) is as worthwhile as a fuller understanding of the socio/economic/cultural environment of village communities and the need for educational programs and services specifically designed to meet these needs. Certainly the need for well-equipped schools and highly motivated and qualified teachers with an awareness of the Native Indian cultural environment should be high on our list of priorities as would any effort to increase the number of Native Indian teachers to serve as educators, role models, and leaders in the village communities.
Is the K-ABC Simultaneous and Sequential Processing Model Useful in the Remediation of Deficiencies in the Academic Achievement of Native Indian Children?

Das (1983) indicated that the K-ABC was perhaps the first standardized test battery that attempted to measure processes and therefore generated information that provided for the development of appropriate remedial instruction. This position was confirmed by Naglieri & Haddad (1984). This is the very advantage of the processing model as it's "proximity to behaviour or performance, describing modes of an individual's functioning in a test situation...as determinants of the processes used by an individual, rather than invoke the notion of abilities" (Das et al, 1975, p. 87). This was also the Kaufmans' intention in designing the K-ABC: that by matching instructional materials to a child's perceptual and cognitive strengths, we can enhance and facilitate the child's ability to learn. However, we may only be on firm ground in making remedial suggestions based on the Simultaneous and Sequential Processing model if the K-ABC does indeed accurately measure these processes. The apparent inability of the K-ABC to accurately measure Simultaneous and Sequential Information Processing may be one of the major reasons why this study does not show the expected pattern of developmental mean score differences in Simultaneous and Sequential Processing for Native and Non-Native children, i.e. a lag in the development of Sequential Processing skills for Native children.

Certainly one cannot argue with the contention that remedial reading programmes would be successful if they were designed in the mode of
processing in which the child is most proficient. Indeed, instructional activities should perhaps always be designed to capitalize on a child's strengths by matching the methods of instruction to the individual perceptual strengths or learning style of the child. However, this study fails to confirm that Native children have a preferred visual learning style and are therefore more proficient in Simultaneous Processing than in Sequential Processing. Thus remedial instruction should be designed to take advantage of the Simultaneous and Sequential strengths of the Native child and take into account the economic/social/cultural uniqueness of the Native village (or reserve) lifestyle. With this in mind, further discussion of remedial instruction techniques based on a child's information processing strengths is warranted.

Das and Molloy (1975) clearly established the "strength" approach to remedial instruction:

It seems reasonable to expect that if teaching methods are modified to capitalize on the simultaneous factor, children showing a preference for this mode of thought would learn more effectively. Conversely, children favouring a successive mode might profit more from a successive approach. (p. 219)

While there is limited research evidence to support this remedial approach, Kaufman & Kaufman (1983c) offer it as one of the primary uses of the K-ABC.

We feel strongly that remediation based on the K-ABC should follow the aptitude-treatment-interaction (ATI) approach...namely, the direct teaching of academic areas by methods that are geared to the child's most efficient mode of processing information. (p. 235)
However, the results of subsequent research offers only tentative support for this approach. There appears to be some advantage (of unknown magnitude) in considering processing abilities in instructional reading activities with grade one children. Any evidence for matching K-ABC processing abilities to instructional reading activities has not been established for preschoolers or for children 6-9 years of age; the evidence is contradictory and inconclusive for children from 9-12 years of age. No conclusive research evidence is available to confirm the desirability of matching K-ABC Information Processing abilities and instructional activities in other academic areas (Salvia & Hritcko, 1984). The reasons for this lack of confirmatory evidence need to be explored insofar as they apply to the planning of instructional activities with Native children.

The Information Processing model implies that a child's preferred processing mode with a set of tasks can be generalized to other tasks or activities. Thus we are not really interested in the child's scores on the Mental Processing Subtests but rather in his preferred pattern of processing, particularly in terms of the instructional implications of such knowledge. This implies an inferential link from performance on the mental processing subtests to performance on reading, spelling, or arithmetic materials. However, this association at this point is only inferential and has not been confirmed by a sound body of research evidence. Goetz & Hall (1984) indicate that:

From an information processing perspective, information provided by the K-ABC is not sufficient to permit adequate understanding of the causes of an individual's performance on the tasks that comprise the instrument, or to illuminate the nature of the individual's capabilities in other contexts. (p 292)
Torgesen & Houck (1980) indicated that the causal link between processing deficits on diagnostic tests and learning problems in school has yet to be established. Thus further research is needed before relationships between Information Processing variables and groups of children can be used to make effective instructional decisions.

Critics of the K-ABC do not reject the position that knowledge of a child's preferred learning style would enable us to design effective instructional materials for specific academic skill development. What they question is whether or not the K-ABC provides adequate assessment of information processing or learning style. There is, unfortunately, no data in the Interpretive Manual (Kaufman & Kaufman, 1983c) to confirm the superiority of instructional procedures based on K-ABC Simultaneous and Sequential profile analysis versus other more traditional instructional reading approaches. Goetz & Hall (1984) discussed this concern about the effectiveness of the K-ABC Simultaneous and Sequential Processing model of instructional intervention as:

Information provided by the K-ABC is not sufficient to permit adequate understanding of the causes of an individual's performance on the tasks that comprise the instrument, or to illuminate the nature of the individual's cognitive capabilities in other contexts. (p. 286)

To be useful in helping us plan instructional/remedial activities, test materials should be related to the types of activities and curricula involved in classroom learning. This is perhaps one of the weakest points of the K-ABC as many Mental Processing Subtest tasks have no counterpart in classroom instructional activities, i.e. Hand Movements.
That a variable is related to achievement and learning is not a sufficient condition for it to be considered in planning school learning. It is one thing to establish a relationship between process variables and achievement or learning for groups of children, but it is quite another matter to make accurate decisions for individual pupils. (Salvia & Hritcko, 1984, p. 347)

These concerns are not directed at the Simultaneous and Sequential Information Processing model but rather at the limitations of the information provided by the K-ABC itself. Goetz & Hall (1984) suggested that relative to any instructional approach, the Simultaneous and Sequential Information Processing model simply lacks required specificity.

Measurement is not direct; the K-ABC, like other standardized IQ tests, samples a narrow range of behaviours on tasks far removed from those encountered by children in classrooms. Moreover, measurement of underlying constructs is imprecise, rendering judgements that are arbitrary and relative. Rather than providing a detailed task analysis as a basis for understanding, interventions developed from the K-ABC are based upon the simultaneous/sequential dichotomy and designed to focus instruction on the general mode of presentation. Thus the K-ABC leaves those responsible for providing instruction without the information and instructional framework they need to best serve their students. (p. 292)

The remaining issue to be examined within the limitations of this paper is that of the differential cultural validity of the K-ABC. Certainly the expectations for developmental differences in Mental Processing skills between Native and Non-Native children were not evident in this study. If we accept the position that the K-ABC is a test of low validity (Sternberg, 1984), then it is not difficult to see why Native/Non-Native differences in mental processing consistent with other research findings did not emerge.
The factor that is probably the most responsible for the diminished cross-cultural differences on the Mental Processing Scale is the absence of items measuring verbal skills.

The importance of verbal skills in the measurement of intelligence is reflected in a number of major theories as well as in standardized tests.

Most of the major theories of intelligence, both psychometric (Cattell, 1971; Guilford, 1967; Thurstone, 1938; Vernon, 1971) and information processing (Hunt, 1980; Sternberg, 1980) have placed major emphasis on verbal skills as an element of intelligence. (Sternberg, 1984, p. 274)

Major intelligence test batteries such as the WISC-R or Stanford-Binet include a significant number of items that measure verbal behaviour. In rejecting this approach, the Kaufmans (1983c) placed all of their measures of verbal skills in the Achievement Scale of the K-ABC, stating that "it seems unreasonable to equate these achieved skills with intellectual functioning" (p. 33). However, vocabulary, a direct measure of verbal behaviour, has been found to be the single subtest that correlates most highly with full scale intelligence (Jensen, 1980; Matarazzo, 1972). Similarly, the K-ABC Achievement Scale correlates more highly with other IQ tests, achievement tests, and school achievement than does either the Simultaneous Processing Scale or the Sequential Processing Scale (Jensen, 1984; Sternberg, 1984). Sverdlik and Lewis (1983) also indicated that the K-ABC Achievement Scale correlated more highly with the Stanford-Binet, the WISC-R Verbal and WISC-R Full Scale IQ's than with the Mental Processing Scale. It appears that the Achievement Scale may measure verbal ability more than it measures achievement (Keith, 1985).
We would expect the non-verbal mental processing tests to correlate much more highly with the WISC-R Performance IQ (non-verbal) than with the WISC-R Verbal IQ. Yet the mean correlation of the 8 mental processing tests with the WISC-R Performance IQ is .36 and with Verbal IQ, .37, a trivial difference. The average $r$ between the mental processing tests and the highly verbal Stanford-Binet is .37. These mental processing tests correlate as much with verbal tests as with non-verbal tests, because $g$ is the major agent of $r$ among all the tests. (Jensen, 1984, p. 17)

An interesting finding is that the Mental Processing Scale "correlates more highly than the Achievement Scale with the external criteria that are generally believed to be the least critical to intelligence" (Sternberg, 1984, p. 275). It is for this reason that Sternberg (1984) indicates that the Kaufmans' insistence on separating verbal behaviour from the measurement of intelligence simply doesn't work, and that this approach has been abandoned by most researchers in cognitive psychology.

It may be premature to accept Sternberg's position that achievement and intelligence are not identical overlapping concepts (Childers, Durham & Bolen, 1985). Village-Native children may experience difficulty in school achievement because they do not make optimal use of Simultaneous and Sequential Processing. The positive correlations between Mental Processing measures and the California Achievement Test reported by Childers et al., (1985) suggest that Mental Processing is related to academic success.

If the Mental Processing Scale, despite the Kaufmans' (1983) efforts to separate acquired knowledge from the measurement of intelligence, is related to achievement as much or more so than the traditional
intelligence tests, then this may account for some portion of the
differences exhibited by the Village-Native children in Reading and Mental
Processing.

It is perhaps reasonable to conclude that the differential (cultural)
validity of the K-ABC, particularly for use with Native Indian children, has
yet to be established. If the K-ABC is to become a useful tool in the
assessment and programming of Native children, it must demonstrate that
it can predict future achievement for Native and Non-Native children
equally effectively. Further long-term studies are needed to establish the
predictive validity of the K-ABC with Native Indian children.

Conclusions.

This study was designed to demonstrate that differences in
information processing are probably not due to ethnic group membership,
and that reading and neurological maturation display developmental
patterns similar to that of simultaneous and sequential processing. The
results of the study support the overall conclusion that differences in
information processing are due to cultural/experiential background and not
ethnic group membership, and that reading and neurological maturation
display developmental patterns similar to that of simultaneous and
sequential processing for the three ethnic groups in the study.

1. There was no “Native Indian pattern” of Simultaneous and Sequential
Information Processing. Differences between the two Native Indian groups
on Information Processing were more significant than differences between
the Non-Native and either Native group.

2. The relationship between Ethnicity and Simultaneous and Sequential
Processing is statistically significant. Statistically significant
differences exist between the three Ethnic groups on Simultaneous and
Sequential Processing. Post-hoc analysis of the variates from the CA of
the Simultaneous and Sequential Processing Subtests indicated that the
Village-Native group was significantly different than the other two Ethnic
groups at every Age level.

3. The relationship between Age and Ethnicity and the Reading Subtests
was statistically significant. While this relationship was highly
significant for Age, it was moderately significant for Ethnic group
membership. Post-hoc analysis revealed that the Village-Native group
was significantly different than the other two Ethnic groups.

4. The relationship between Age and Ethnicity and Neurological Maturation
was statistically significant. Post-hoc analysis revealed substantial
linear trends with Age and significance differences between the three
Ethnic groups.

It is perhaps necessary to consider why the Village-Native group would
exhibit significant differences in the Simultaneous and Sequential
Processing, Reading, and Neurological Maturation variables to the other
two groups, and in particular, to the City-Native group. It could be argued
that a natural selection factor is involved in the composition of the two
Native communities. Differences in motivation, assertiveness, abilities, competitiveness, ambition, and attitude toward education and lifestyle may encourage many Native families to move away from the more traditional village communities. While these factors were not measured as part of this study, they may in part account for the observed differences between the two Native groups. Other factors such as nutrition, birthweight, family size, etc may contribute to the differences in the neurological measures. Further research is needed with these variables and with other Native tribal groups.

Differences in the cultural/economic environments of the village communities and Prince Rupert cannot be overlooked. Cognitive skills are always a reflection of cultural experience (Maccoby & Modiano, 1971). The differences between the Village-Native and City-Native groups may therefore be no more than differences in cultural adaptation (Berry, 1983). The dynamics of the family sub-culture may have similar influence on the cognitive development of the Native child. In this way, such influences as child rearing practices, mother-child interaction (Vyas, 1983), family size and birth order (Brody & Brody, 1976), parental ambition and aspiration (Cummins, 1982; 1984), and family interaction, may be very much involved in the development of the Native child's cognitive skills. However, these factors may not be the same for the Village-Native child, as compared to the City-Native child, because of the more traditional lifestyle of the village communities.

Attention has been drawn previously in this paper to the rather profound differences in the economic lifestyle of Native versus Non-Native
peoples in Canada. This disparity may also be true of the Village- versus the City-Native peoples. There is ample evidence in the literature that SES can have considerable influence on the development of cognitive skills (Mercer, 1979; Sattler, 1982; Lesser, Fifer & Clark, 1965). One of the significant outcomes of economic impoverishment is a reduction in the quality of the learning environment in the home (Marjoribanks, 1980). The lower SES child may have fewer opportunities and materials for learning in a home environment that is not conducive to the fullest development of his/her cognitive potential.

Lower SES children may not only begin their formal schooling with some disadvantage in experiences, skills, and attitudes as compared to their more economically fortunate peers, but these differences may be reinforced by the school environment itself. The behaviours, language, and perceptual abilities that may be a reflection of the child's experiential background (Edgerton & Langress, 1979; Shade, 1981), may have significant influence on teacher attitudes and the child's achievement.

Differences in language skills, which were not measured in this study, can also account for the observed differences between the Village-Native and City-Native groups on the dependent variables. This researcher did notice a greater tendency for the City-Native children to engage in spontaneous conversation as compared to the Village-Native children. The Village-Native children often replied with one- or two-word answers or with gestures. This tendency to avoid the use of language in preference for other means of communication may have considerable impact on the development of cognitive skills (Alleyne, 1977). Cummins (1982; 1984)
and Rees (1982) have indicated that a child's level of language proficiency can influence the development of his/her cognitive skills.

It is also not known to what extent that the Native language is used in the Village-Native home versus the City-Native home. It is possible that some of the Village-Native children are raised in bilingual homes and develop less than adequate proficiency in either language. If this is the case, then the Village-Native child would be expected to display less than optimum performance on tests of cognitive abilities (Cummins, 1982; 1984). Further research is needed with these language related issues with both Native groups.

Finally, the City-Native children may have some advantage in response style or "test wiseness" that is a function of their city lifestyle. This researcher found the Village-Native children very slow to respond and with an economy of words as compared to the City-Native children. Children living in more traditional (village) communities may naturally encounter greater difficulty with the tasks and language of formalized testing situations (Rogoff, 1981; Van der Flier, 1977). If this is the case, then the observed differences between the two Native groups were truly measures of cultural/experiential factors rather than measures of differences in cognitive skills.
Recommendations for Further Research.

The following recommendations are offered in view of the results of this study.

1. Further research efforts should concentrate on differences between Village- (or reserve) Native and City-Native children in recognition of the unique environment and lifestyle of the village/reserve communities.

2. Visual and auditory screening measures should be administered to determine if Native children are more prone to perceptual handicaps (particularly in view of the known prevalence of otitis media among Native populations). The results of these perceptual measures could be correlated with Reading and Mental Processing data.

3. Language measures (such as the Peabody Picture Vocabulary Test-Revised) should be administered to the Native children to determine the extent of their reading-associated language skills which can have a significant impact on academic achievement. It is anticipated that this would be a highly significant measure in discriminating between the two Native groups.

4. The K-ABC Achievement Scale should be administered to obtain a measure of the differences in acquired knowledge between the three cultural groups as compared to Mental Processing, Neurological Maturation, perceptual abilities, and reading. This would also allow for a predictive validity study of the entire K-ABC with Native Indian children.
5. The B.C. QUIET Arithmetic and Spelling subtests should be administered as further measures of achievement to be compared to the K-ABC, Neurological Maturation, and perceptual variables. The Simultaneous and Sequential Processing model would suggest that there would be a stronger relationship between spelling and Sequential Processing...and a stronger relationship between arithmetic and Simultaneous Processing.

6. A standardized measure of achievement, such as the B.C. QUIET, should be administered 1-2 years later to the same sample of children in order to determine the predictive validity of the Mental Processing Scale for Native and Non-Native children. This recommendation recognizes the need for predictive validity studies with the K-ABC, and specifically for establishment of the predictive validity of the K-ABC with Native Indian children.

7. In view of the differences between the Village-Native and City-Native children illustrated by this study, background information such as birthweight, family size, gestation period, maternal nutrition, health factors, developmental milestones, number of books in the home, frequency of adult/child reading, etc, should be surveyed for possible impact on Mental Processing, Reading, and Neurological Maturation.

8. Ways of improving educational services in the village communities should be investigated. This recommendation recognizes the observed differences between the Village-Native and City-Native children in Mental Processing and Reading. Efforts should also be directed toward making the village schools more actively involved in the cultural life of the village.
communities, and in selecting teachers who are knowledgable, sensitive, and sympathetic to the needs and cultural traditions of the Native people. Particular emphasis should be directed toward recruiting teachers who are effective in the village schools and are willing to live in the Indian communities for more than just a year or two. The ultimate solution to this problem may be to increase the number of Native Indian teachers in the village schools.
BIBLIOGRAPHY


Baumanometer. W.A. Baum Company, Incorporated, Copiague, N.Y.


National Indian Brotherhood (1972). *Indian control of Indian education*. Policy paper presented to the Minister of Indian Affairs and Northern Development.


## APPENDIX

Map of Prince Rupert Region ........................................................................................................... 235
General Information Letter ............................................................................................................. 236
Teacher Information Letter ............................................................................................................ 237
Parental Information Letter ........................................................................................................... 238
Parental Consent Form .................................................................................................................... 239
Principal’s Supporting Letter .......................................................................................................... 240

List of Figures:

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 11</td>
<td>Cell Means for Simultaneous Processing for Village-Native, Non-Native, and City-Native Children</td>
<td>241</td>
</tr>
<tr>
<td>Figure 12</td>
<td>Cell Means for Sequential Processing for Village-Native, Non-Native, and City-Native Children</td>
<td>241</td>
</tr>
<tr>
<td>Figure 13</td>
<td>Cell Means for Simultaneous Processing Subtests for Village-Native Children</td>
<td>242</td>
</tr>
<tr>
<td>Figure 14</td>
<td>Cell Means for Simultaneous Processing Subtests for Non-Native Children</td>
<td>242</td>
</tr>
<tr>
<td>Figure 15</td>
<td>Cell Means for Simultaneous Processing Subtests for City-Native Children</td>
<td>243</td>
</tr>
<tr>
<td>Figure 16</td>
<td>Cell Means for Gestalt Closure Subtest for Village-Native, Non-Native, and City-Native Children</td>
<td>243</td>
</tr>
<tr>
<td>Figure 17</td>
<td>Cell Means for Triangles Subtest for Village-Native, Non-Native, and City-Native Children</td>
<td>244</td>
</tr>
<tr>
<td>Figure 18</td>
<td>Cell Means for Matrix Analogies Subtest for Village-Native, Non-Native, and City-Native Children</td>
<td>244</td>
</tr>
<tr>
<td>Figure 19</td>
<td>Cell Means for Photo Series Subtest for Village-Native, Non-Native, and City-Native Children</td>
<td>245</td>
</tr>
<tr>
<td>Figure 20</td>
<td>Cell Means for Spatial Memory Subtest for Village-Native, Non-Native, and City-Native Children</td>
<td>245</td>
</tr>
<tr>
<td>Figure 21</td>
<td>Cell Means for Sequential Processing Subtests for Village-Native Children</td>
<td>246</td>
</tr>
<tr>
<td>Figure 22</td>
<td>Cell Means for Sequential Processing Subtests for Non-Native Children</td>
<td>246</td>
</tr>
<tr>
<td>Figure 23</td>
<td>Cell Means for Sequential Processing Subtests for City-Native Children</td>
<td>247</td>
</tr>
<tr>
<td>Figure 24</td>
<td>Cell Means for Hand Movements Subtest for Village-Native, Non-Native, and City-Native Children</td>
<td>247</td>
</tr>
</tbody>
</table>
Figure 25: Cell Means for Number Recall Subtest for Village-Native, Non-Native, and City-Native Children

Figure 26: Cell Means for Word Order Subtest for Village-Native, Non-Native, and City-Native Children

Figure 27: Cell Means of Simultaneous and Sequential Processing for Village-Native Children

Figure 28: Cell Means of Simultaneous and Sequential Processing for Non-Native Children

Figure 29: Cell Means of Simultaneous and Sequential Processing for City-Native Children

Figure 30: Cell Means of Word Identification Subtest for Village-Native, Non-Native, and City-Native Children

Figure 31: Cell Means of Passage Comprehension Subtest for Village-Native, Non-Native, and City-Native Children

Figure 32: Cell Means of Reading Understanding Subtest for Village-Native, Non-Native, and City-Native Children

Figure 33: Cell Means of Reading Subtests for Village-Native Children

Figure 34: Cell Means of Reading Subtests for Non-Native Children

Figure 35: Cell Means of Reading Subtests for City-Native Children

Figure 36: Cell Means of Grip Strength Dominant Hand Subtest for Village-Native, Non-Native, and City-Native Children

Figure 37: Cell Means of Grip Strength Other Hand Subtest for Village-Native, Non-Native, and City-Native Children
Figure 11: Cell Means of Simultaneous Processing Scores for Village-Native, Non-Native, and City-Native Children.

Figure 12: Cell Means of Sequential Processing Scores for Village-Native, Non-Native, and City-Native Children.
Figure 13: Cell Means of Simultaneous Processing Subtests for Village-Native Children.

Figure 14: Cell Means of Simultaneous Processing Subtests for Non-Native Children.
Figure 15: Cell Means of Simultaneous Processing Subtests for City-Native Children.

Figure 16: Cell Means of Gestalt Closure Subtest for Village-Native, Non-Native, and City-Native Children.
Figure 17: Cell Means of Triangles Subtest for Village-Native, Non-Native, and City-Native Children.

Figure 18: Cell Means for Matrix Analogies Subtest for Village-Native, Non-Native, and City-Native Children.
Figure 19: Cell Means for Photo Series Subtest for Village-Native, Non-Native, and City-Native Children.

Figure 20: Cell Means for Spatial Memory Subtest for Village-Native, Non-Native, and City-Native Children.
Figure 21: Cell Means for Sequential Processing Subtests for Village-Native Children.

Figure 22: Cell Means for Sequential Processing Subtests for Non-Native Children.
Figure 23: Cell Means for Sequential Processing Subtests for City-Native Children.

Figure 24: Cell Means for Hand Movements Subtest for Village-Native, Non-Native, and City-Native Children.
Figure 25: Cell Means for Number Recall Subtest for Village-Native, Non-Native, and City-Native Children.

Figure 26: Cell Means for Word Order Subtest for Village-Native, Non-Native, and City-Native Children.
Figure 27: Cell Means for Simultaneous and Sequential Processing for Village-Native Children.

Figure 28: Cell Means for Simultaneous and Sequential Processing for Non-Native Children.
Figure 29: Cell Means for Simultaneous and Sequential Processing for City-Native Children.

Figure 30: Cell Means for Word Identification Subtest for Village-Native, Non-Native, and City-Native Children.
Figure 31: Cell Means for Passage Comprehension Subtest for Village-Native, Non-Native, and City-Native Children.

Figure 32: Cell Means for Reading Understanding Subtest for Village-Native, Non-Native, and City-Native Children.
Figure 33: Cell Means on Reading Subtests for Village-Native Children.

Figure 34: Cell Means on Reading Subtests for Non-Native Children.
Figure 35: Cell Means on Reading Subtests for City-Native Children.

Figure 36: Cell Means on Grip Strength Dominant Hand Subtest for Village-Native, Non-Native, and City-Native Children.
Figure 37: Cell Means on Grip Strength Other Hand Subtest for Village-Native, Non-Native, and City-Native Children.