TYPE OF SCHOOLING, SOCIOECONOMIC STATUS, GRADE LEVEL AND SEX DIFFERENCES ON RAVEN'S PROGRESSIVE MATRICES TEST

A Thesis

Presented to

The School of Graduate Studies

Addis Ababa University

In Partial Fulfilment of the Requirements

for the Degree of Master of Arts

in Educational Psychology

By

Fisseha Mekonnen

June, 1992

ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

TYPE OF SCHOOLING, SOCIOECONOMIC STATUS, GRADE LEVEL AND SEX DIFFERENCES ON RAVEN'S PROGRESSIVE MATRICES TEST

BY

FISSEHA MEKONNEN

FACULTY OF EDUCATION

DEPARTMENT OF PSYCHOLOGY

Approval by Board of Examiners:

Dr. Makonnen Yimer	
Chairman, Department Graduate Committee	
Dr. Abraham Hussein	
Advisor	
Dr. Joachim Wagner	J. Wagner
Examiner	
AHMAZ ESHETE	
Examiner	
Examiner	

ACKNOWLEDGEMENT

Many people have helped me in doing this research. Listing all the names is very difficult. However a few deserve special gratitude. First, I would like to thank Dr. Abraham Hussein for his advice in reshaping my work. I am also very grateful to Ato Daniel Desta, Ato Abdinasir Ahmed and Ato Desalegn Chalchisa the staff members of the Testing Center of AAU, and to School Directors, Teachers and above all students who participated in the study.

I would like to express my gratitude to Dr. Mekonnen Yimer whose devoted collaboration was not altered from the beginning to the end of the study.

My special thanks are due to Ato Amare Mezgebu, Ato Jemaneh Anbesso, Ato Yared Ephrem, Ato Zewdu Lemma and to all my friends who encouraged me to withstand the rigour of graduate studies.

I am very much indebted to my mother Weizero Mazaa Kebebew, to my father Ato Mekonnen Alemu and to my sisters who helped me much during my stay in graduate studies.

I own an invaluable debt of gratitude to Chuchu without whose unstinging and unfailing help, selfless and devoted collaboration timely accomplishment would have been enormously difficult.

TABLE OF CONTENTS

LIST OF FIGURES

ABSTRACT

The purpose of this study was to examine whether or not scores on Raven's Standard Progressive Matrices Test, a 'culture-fair' measure of general mental ability, are affected by cultural and environmental influences.

The Raven's Standard Progressive Matrices Test (1958) was therefore, administred to 599, Seventh-, ninth-, and eleventh-grade Ethiopian students who had a considerably heterogeneous cultural and environmental experiences. It was hypothesized that, the mean scores obtained on the Raven's Standard Progressive Matrices Test would not be different when the subjects are grouped under type of schooling, socioeconomic status, grade level and sex.

Different levels of factorial designs were employed to examine group mean differences, and simple and partial correlations were computed in examining relationships between the Raven's Test and the treatment variables.

The results of the study indicated that, mean scores on the Raven's Test vary significantly with type of schooling, SES, and grade level. No significant mean difference was obtained for sex. In addition, very low but significant correlations were obtained between the Raven's Test and the treatment variables except with sex.

The results generally support the previous findings obtained in other contexts, and suggest that the Raven's Test is not a 'culture-fair' test of general mental ability. Future research may be undertaken to find out the effect of factors considered in this study and other factors with regard to the usefulness of the Raven's Test, more specifically the influence of environmental experiences and academic achievement on the Raven Test.

CHAPTER ONE

1. INTRODUCTION

1.1. Background to the Problem

Regarding the development of human mental ability, there are different theories which have led to different views (Sprott, 1980). Of these theories and views belong: The Factory theory (Spearman, Burt, Thurstone, Vernon, Raven, Guilford); The Environmental theory (Watson, Throndike, Skinner); The Inheritance theory (Galton, Hall, Cattell, Terman, Jensen); The Genetic-Epistemological theory (Piaget, Inhelder, Flavel); and The Information Processing theory (Atkinson, Schifrin, Sternberg). Each theory attempts to explain the nature and organization of mental ability in its own way. Despite various attempts made researchers and theorists could not reach at a single accepted theory of mental ability.

There is specially one basic disagreement among researchers aimed at developing a comprehensive theory of mental ability, i.e. the determination of the relative contributions of environmental and genetic factors to the development of mental ability (Loevinger, 1943; Dandes and Dow, 1969; Thorndike & Hagen, 1977). And this in turn implies that influencial factors upon mental ability can in general be categorized into genetic and environmental factors.

Whereas genetic factors include those influences due to hereditary effects in general, environmental factors consist of all influences that are not attributable to hereditary effects. Development of the brain, the nervous system, and the senses are genetically influenced and affect mental ability directly. Child-rearing practices, educational experiences, cultural factors... etc. are some of the factors that are included under environmental factors (Jones, 1954).

Investigations undertaken to study mental ability considering the disagreement stated earlier seem to focus on the identification of factors with larger share of contribution to the differences in mental ability between and within groups rather than focusing on the disagreement (Thorndike, 1968). While most investigations, thus, are involved in the construction of instruments, a few are preoccupied with expanding original theories (Sternberg & Detterman, 1981).

As Cronbach (1970) stated, appropriate construction and application of instruments provide firm plat form to psychological testing. Mental ability is thus, can be represented using numerical estimations which can relatively explain mental ability in a more observable way.

Different kinds of instruments are applicable for getting numerical representations of mental ability. Some instruments

are culture specific which assume to measure primarily environmental experiences of an individual. Since these instruments are highly related with culture, they are commonly known as 'culture-loaded' tests of mental ability. Those group of instruments on the other hand, which assume to measure genetic based mental abilities are quantitative representations of unbiased individual differences in mental ability (Jensen, 1980). Therefore differences in sex, age, educational experience, social class culture, natural environmental conditions, ... etc. are believed to be noninfluential to the performance of an individual on the instruments unlike to culture-specific or culture-loaded tests of mental ability. The performance is claimed to show genetic differences. Such instruments are known as 'culture-fair' tests (Jensen, 1969; 1980; Cronbach, 1970; Anastasi, 1976).

'Culture-fair' test of mental ability is thus, a test with items that do not produce any systematic advantage for a specific group or individuals. That they measure general mental ability 'g' is a typical feature of such tests (Raven, 1961; Jensen, 1969; 1980). Raven's Standard Progressive Matrices Test is one of the existing 'culture-fair' tests of general mental ability with a popular advantage in conducting cross-cultural psychological investigations (Anastasi, 1976; Jensen, 1980).

Raven's Standard Progressive Matrices Test as an instrument of cross-cultural investigation aims at refinment of theories of mental ability on one hand, and identification of environmental factors which facilitate or retard the development of mental ability on the other hand (Vernon, 1965). Such a benefit from the Raven's Test also has got support from Vernon (1969) in that its application particularly in societies where standardized psychological tests of mental ability are unavailable is legitimate in examining major determinants within a culture. Anastasi (1976) accepts what Vernon has suggested but recommended a precaution in using the test. That is to examine whether the test is 'culture-fair' or not within specific socio-cultural settings before it is applied for any purpose.

Similar primary investigations of the Raven's Standard Progressive Matrices Test are prerequisites for its applications in Ethiopian socio-cultural settings. Specially the test has to be examined in relation with environmental conditions so that to see its 'culture-fairness'.

The present study in general attempts to focus on the primary investigation of the Raven's Standard Progressive Matrices Test in Ethiopian individuals.

1.2. Statement of the Problem

The Raven's Standard Progressive Matrices Test (SPM)

is a widely used instrument of measuring mental ability probably because it is simple to administer in a variety of cultural settings; because it is a non-verbal test; and because it serves different research purposes where there is no psychological test of mental ability (Vernon, 1965; Klingelhofer, 1967).

Raven, the author of the test, notes that the test has no relationship with environmental factors (Raven, 1961). However, different investigators on the test report different findings on the cross-cultural applications of the test. Some of them (Jensen, 1969; 1980; Baraheni, 1974; Vernon, 1979) support what Raven claimed. Other investigators report against the claim Raven has made (Cronbach, 1970; Anastasi, 1976).

Though several investigators accept the capacity of the test to measure 'g' almost purely (Jensen, 1969), its application as a 'culture-fair' test of general mental ability is not taken for granted. Biasing effects of environmental factors such as socio-cultural conditions are acknowledged in research reports against the test's fundamental position (Tulkin and Newbrough, 1968).

However, as stated earlier, with all complaints on the employment of the SPM, it continued to serve as a popular cross-cultural instrument specially in developing societies

(For example, the application of the test is widely employed in African cultures, MacArthur and others, 1964). Primary investigations on the SPM Test in these socieites are usually done in line with its degree of assistance in placement decisions (Wober, 1969); in interpretation of achievement performance (Klingelhofer, 1967); in prediction of educational success (Baraheni, 1974); and identification of mentally gifted and retarded children (Croman & Budoff, 1974).

In Ethiopian condition, however, information regarding placement decisions, regarding prediction of academic success and regarding individual talents and skills are not obtained by the use of mental ability tests. Because, primarily mental ability tests of any type (either culture-specific or 'culture-fair') are not available even though attempts had been made (Langmuir, 1967; Lakew, 1974). Particularly those factors such as developmental stages, environmental factors, group influences, ability patterns and educational experiences are not investigated in relation with mental abilities of Ethiopian individuals.

Langmuir (1967) emphasizing the importance of mental ability tests suggest the possibility of using 'culture-fair' tests in relation to the evaluation of pupils, the urban-rural contrasts, attitudes of students, and the problem of language abilities. Bowers (1969) supporting

Lɔngmuir's view recommended the employment of non-verbal tests, that are less 'culture-contaminated' to predict academic success and English language ability.

Realizing the development of new mental ability tests which consider Ethiopian psychological, cultural and social make up would be a task of much difficulties, thus, it may be convincing to follow what Lɔngmuir, and Bowers have suggested.

Therefore, in an attempt to fill the gap in testing mental ability, the present study investigates the 'culture-fairness' of Raven's Standard Progressive Matrices Test.

1.3. Objectives of the Study

The general purpose of this study is to examine the applicability of the Raven's Standard Progressive Matrices Test as a 'cultural-fair' test of general mental ability in the Ethiopian condition.

The specific questions that the study attempts to answer are the following:

1. Is there a statistically significant difference between the mean general mental ability scores of students learning at Government and Non-Government schools ?

2. Is there a statistically significant difference between the mean general mental ability scores of students from upper and lower socioeconomic background ?

3. Is there a statistically significant difference between the mean general mental ability scores of students from grades seven, nine and eleven ?

4. Is there a statistically significant difference between the mean general mental ability scores of male and female students ?

The study is also aimed at examining the overall and independent relationships between the selected variables - type of schooling, socioeconomic status, grade level, and sex - and general mental ability.

The scope of the study is delimited by the use of data collected from selected schools in Addis Ababa due to reasons of management of time, finance, materials and access to relevant and reliable data.

1.4. Operational Definition

Definitions of major terms used in this study are given below.

a) General Mental ability: refers to the degree of

performance on the Raven's Standard Progressive Matrices Test (SPM) (1958). The test includes the ability to perceive, compare, identify relationships and the use of clear thinking and abstract reasoning. It is denoted by general mental ability score.

b) Type of schooling: refers to the type of schooling that an individual subject is enrolled. Two types of schooling - Government and Non-Government - are identified in this study.

c) Socioeconomic Status (SES): in this study SES is represented by an adapted index of socioeconomic characteristics (ISC). Father's or guardian's occupation and education level are used to determine a subject's social position. Two SES groups are identified in this study - upper and lower SES groups.

d) Grade Level: refers to the grade level in which a student is enrolled. Three grade levels - Grades seven, nine, and eleven are included in the study.

1.5. Significance of the Study

This study is believed to contribute to the following

TYPE OF SCHOOLING, SOCIOECONOMIC STATUS, GRADE LEVEL AND SEX DIFFERENCES ON RAVEN'S PROGRESSIVE MATRICES TEST

A Thesis

Presented to

The School of Graduate Studies

Addis Ababa University

In Partial Fulfilment of the Requirements

for the Degree of Master of Arts

in Educational Psychology

By

Fisseha Mekonnen

June, 1992

ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

TYPE OF SCHOOLING, SOCIOECONOMIC STATUS, GRADE LEVEL AND SEX DIFFERENCES ON RAVEN'S PROGRESSIVE MATRICES TEST

BY

FISSEHA MEKONNEN

FACULTY OF EDUCATION

DEPARTMENT OF PSYCHOLOGY

Approval by Board of Examiners:

Dr. Mekonnen Yimer — Chairman, Department Graduate Committee

Dr. Abraham Hussein — Advisor

Dr. Joachim Wagner — Examiner

AHMAZ ESHETE — Examiner

Examiner

ACKNOWLEDGEMENT

Many people have helped me in doing this research. Listing all the names is very difficult. However a few deserve special gratitude. First, I would like to thank Dr. Abraham Hussein for his advice in reshaping my work. I am also very grateful to Ato Daniel Desta, Ato Abdinasir Ahmed and Ato Desalegn Chalchisa the staff members of the Testing Center of AAU, and to School Directors, Teachers and above all students who participated in the study.

I would like to express my gratitude to Dr. Mekonnen Yimer whose devoted collaboration was not altered from the beginning to the end of the study.

My special thanks are due to Ato Amare Mezgebu, Ato Jemaneh Anbesso, Ato Yared Ephrem, Ato Zewdu Lemma and to all my friends who encouraged me to withstand the rigour of graduate studies.

I am very much indebted to my mother Weizero Mazaa Kebebew, to my father Ato Mekonnen Alemu and to my sisters who helped me much during my stay in graduate studies.

I own an invaluable debt of gratitude to Chuchu without whose unstinging and unfailing help, selfless and devoted collaboration timely accomplishment would have been enormously difficult.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

The purpose of this study was to examine whether or not scores on Raven's Standard Progressive Matrices Test, a 'culture-fair' measure of general mental ability, are affected by cultural and environmental influences.

The Raven's Standard Progressive Matrices Test (1958) was therefore, administred to 599, Seventh-, ninth-, and eleventh-grade Ethiopian students who had a considerably heterogeneous cultural and environmental experiences. It was hypothesized that, the mean scores obtained on the Raven's Standard Progressive Matrices Test would not be different when the subjects are grouped under type of schooling, socioeconomic status, grade level and sex.

Different levels of factorial designs were employed to examine group mean differences, and simple and partial correlations were computed in examining relationships between the Raven's Test and the treatment variables.

The results of the study indicated that, mean scores on the Raven's Test vary significantly with type of schooling, SES, and grade level. No significant mean difference was obtained for sex. In addition, very low but significant correlations were obtained between the Raven's Test and the treatment variables except with sex.

The results generally support the previous findings obtained in other contexts, and suggest that the Raven's Test is not a 'culture-fair' test of general mental ability. Future research may be undertaken to find out the effect of factors considered in this study and other factors with regard to the usefulness of the Raven's Test, more specifically the influence of environmental experiences and academic achievement on the Raven Test.

CHAPTER ONE

1. INTRODUCTION

1.1. Background to the Problem

Regarding the development of human mental ability, there are different theories which have led to different views (Sprott, 1980). Of these theories and views belong: The Factory theory (Spearman, Burt, Thurstone, Vernon, Raven, Guilford); The Environmental theory (Watson, Throndike, Skinner); The Inheritance theory (Galton, Hall, Cattell, Terman, Jensen); The Genetic-Epistemological theory (Piaget, Inhelder, Flavel); and The Information Processing theory (Atkinson, Schifrin, Sternberg). Each theory attempts to explain the nature and organization of mental ability in its own way. Despite various attempts made researchers and theorists could not reach at a single accepted theory of mental ability.

There is specially one basic disagreement among researchers aimed at developing a comprehensive theory of mental ability, i.e. the determination of the relative contributions of environmental and genetic factors to the development of mental ability (Loevinger, 1943; Dandes and Dow, 1969; Thorndike & Hagen, 1977). And this in turn implies that influencial factors upon mental ability can in general be categorized into genetic and environmental factors.

Whereas genetic factors include those influences due to hereditary effects in general, environmental factors consist of all influences that are not attributable to hereditary effects. Development of the brain, the nervous system, and the senses are genetically influenced and affect mental ability directly. Child-rearing practices, educational experiences, cultural factors... etc. are some of the factors that are included under environmental factors (Jones, 1954).

Investigations undertaken to study mental ability considering the disagreement stated earlier seem to focus on the identification of factors with larger share of contribution to the differences in mental ability between and within groups rather than focusing on the disagreement (Thorndike, 1968). While most investigations, thus, are involved in the construction of instruments, a few are preoccupied with expanding original theories (Sternberg & Detterman, 1981).

As Cronbach (1970) stated, appropriate construction and application of instruments provide firm plat form to psychological testing. Mental ability is thus, can be represented using numerical estimations which can relatively explain mental ability in a more observable way.

Different kinds of instruments are applicable for getting numerical representations of mental ability. Some instruments

are culture specific which assume to measure primarily environmental experiences of an individual. Since these instruments are highly related with culture, they are commonly known as 'culture-loaded' tests of mental ability. Those group of instruments on the other hand, which assume to measure genetic based mental abilities are quantitative representations of unbiased individual differences in mental ability (Jensen, 1980). Therefore differences in sex, age, educational experience, social class culture, natural environmental conditions, ... etc. are believed to be noninfluential to the performance of an individual on the instruments unlike to culture-specific or culture-loaded tests of mental ability. The performance is claimed to show genetic differences. Such instruments are known as 'culture-fair' tests (Jensen, 1969; 1980; Cronbach, 1970; Anastasi, 1976).

'Culture-fair' test of mental ability is thus, a test with items that do not produce any systematic advantage for a specific group or individuals. That they measure general mental ability 'g' is a typical feature of such tests (Raven, 1961; Jensen, 1969; 1980). Raven's Standard Progressive Matrices Test is one of the existing 'culture-fair' tests of general mental ability with a popular advantage in conducting cross-cultural psychological investigations (Anastasi, 1976; Jensen, 1980).

Raven's Standard Progressive Matrices Test as an instrument of cross-cultural investigation aims at refinment of theories of mental ability on one hand, and identification of environmental factors which facilitate or retard the development of mental ability on the other hand (Vernon, 1965). Such a benefit from the Raven's Test also has got support from Vernon (1969) in that its application particularly in societies where standardized psychological tests of mental ability are unavailable is legitimate in examining major determinants within a culture. Anastasi (1976) accepts what Vernon has suggested but recommended a precaution in using the test. That is to examine whether the test is 'culture-fair' or not within specific socio-cultural settings before it is applied for any purpose.

Similar primary investigations of the Raven's Standard Progressive Matrices Test are prerequisites for its applications in Ethiopian socio-cultural settings. Specially the test has to be examined in relation with environmental conditions so that to see its 'culture-fairness'.

The present study in general attempts to focus on the primary investigation of the Raven's Standard Progressive Matrices Test in Ethiopian individuals.

1.2. Statement of the Problem

The Raven's Standard Progressive Matrices Test (SPM)

is a widely used instrument of measuring mental ability probably because it is simple to administer in a variety of cultural settings; because it is a non-verbal test; and because it serves different research purposes where there is no psychological test of mental ability (Vernon, 1965; Klingelhofer, 1967).

Raven, the author of the test, notes that the test has no relationship with environmental factors (Raven, 1961). However, different investigators on the test report different findings on the cross-cultural applications of the test. Some of them (Jensen, 1969; 1980; Baraheni, 1974; Vernon, 1979) support what Raven claimed. Other investigators report against the claim Raven has made (Cronbach, 1970; Anastasi, 1976).

Though several investigators accept the capacity of the test to measure 'g' almost purely (Jensen, 1969), its application as a 'culture-fair' test of general mental ability is not taken for granted. Biasing effects of environmental factors such as socio-cultural conditions are acknowledged in research reports against the test's fundamental position (Tulkin and Newbrough, 1968).

However, as stated earlier, with all complaints on the employment of the SPM, it continued to serve as a popular cross-cultural instrument specially in developing societies

(For example, the application of the test is widely employed in African cultures, MacArthur and others, 1964). Primary investigations on the SPM Test in these socieites are usually done in line with its degree of assistance in placement decisions (Wober, 1969); in interpretation of achievement performance (Klingelhofer, 1967); in prediction of educational success (Baraheni, 1974); and identification of mentally gifted and retarded children (Croman & Budoff, 1974).

In Ethiopian condition, however, information regarding placement decisions, regarding prediction of academic success and regarding individual talents and skills are not obtained by the use of mental ability tests. Because, primarily mental ability tests of any type (either culture-specific or 'culture-fair') are not available even though attempts had been made (Langmuir, 1967; Lakew, 1974). Particularly those factors such as developmental stages, environmental factors, group influences, ability patterns and educational experiences are not investigated in relation with mental abilities of Ethiopian individuals.

Langmuir (1967) emphasizing the importance of mental ability tests suggest the possibility of using 'culture-fair' tests in relation to the evaluation of pupils, the urban-rural contrasts, attitudes of students, and the problem of language abilities. Bowers (1969) supporting

Lòngmuir's view recommended the employment of non-verbal tests, that are less 'culture-contaminated' to predict academic success and English language ability.

Realizing the development of new mental ability tests which consider Ethiopian psychological, cultural and social make up would be a task of much difficulties, thus, it may be convincing to follow what Lòngmuir, and Bowers have suggested.

Therefore, in an attempt to fill the gap in testing mental ability, the present study investigates the 'culture-fairness' of Raven's Standard Progressive Matrices Test.

1.3. Objectives of the Study

The general purpose of this study is to examine the applicability of the Raven's Standard Progressive Matrices Test as a 'cultural-fair' test of general mental ability in the Ethiopian condition.

The specific questions that the study attempts to answer are the following:

1. Is there a statistically significant difference between the mean general mental ability scores of students learning at Government and Non-Government schools ?

2. Is there a statistically significant difference between the mean general mental ability scores of students from upper and lower socioeconomic background ?

3. Is there a statistically significant difference between the mean general mental ability scores of students from grades seven, nine and eleven ?

4. Is there a statistically significant difference between the mean general mental ability scores of male and female students ?

The study is also aimed at examining the overall and independent relationships between the selected variables - type of schooling, socioeconomic status, grade level, and sex - and general mental ability.

The scope of the study is delimited by the use of data collected from selected schools in Addis Ababa due to reasons of management of time, finance, materials and access to relevant and reliable data.

1.4. Operational Definition

Definitions of major terms used in this study are given below.

a) General Mental ability: refers to the degree of

performance on the Raven's Standard Progressive Matrices Test (SPM) (1958). The test includes the ability to perceive, compare, identify relationships and the use of clear thinking and abstract reasoning. It is denoted by general mental ability score.

b) Type of schooling: refers to the type of schooling that an individual subject is enrolled. Two types of schooling - Government and Non-Government - are identified in this study.

c) Socioeconomic Status (SES): in this study SES is represented by an adapted index of socioeconomic characteristics (ISC). Father's or guardian's occupation and education level are used to determine a subject's social position. Two SES groups are identified in this study - upper and lower SES groups.

d) Grade Level: refers to the grade level in which a student is enrolled. Three grade levels - Grades seven, nine, and eleven are included in the study.

1.5. Significance of the Study

This study is believed to contribute to the following

practical and theoretical aspects of the application of SPM Test as a 'culture-fair' and a cross-cultural instrument of measuring general mental ability.

a) It may help in obtaining additional information in understanding the characteristics of the test.

b) It may help to identify the contribution of environmental factors to mental ability.

c) It may throw light on the employment of the test for different purposes such as prediction of academic success, and guidance and Counseling.

d) Other related research areas may be identified based on the findings of this study.

1.6. Organization of the Study

Next to this introductory part, chapter Two will survey literature related to the objectives of the study. Particularly literature related to the measurement of general mental ability; the development and application of Raven's Standard Progressive Matrices Test; and cross-cultural investigations using Raven's Standard Progressive Matrices Test are reviewed.

Chapter Three discusses design of the study which includes background issues on subjects, sampling procedures,

development and utilization of measuring instruments, and procedures of data collection and statistical analyses. Chapter Four deals with all the statistical results, analyses and interpretations. Presentation of the discussion based on the results of the study will be given on chapter Five. The last chapter focuses on summary and conclusion.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1. The Measurement of General Mental Ability

The study of human mental ability began to get attention at the time of Sir Francis Galton (Guilford, 1967; Anastasi, 1976). His statistical methods and psychological approaches can be taken as the source of the present trend in measurement and interpretation of psychological tests. Interpretations which were given to the obtained results in investigations of mental ability by Galton were entirely genetic and based on natural gift (Skemp, 1979). But later, this description put difficulties in understanding the relative contribution of environmental factors to the development of mental ability. The failure in explaining these factors had given hints to the American psychologist James McKeen Cattell, whose researches, beginning from 1890 on the predictive capacity of mental tests, followed new lines (Guilford, 1967, Anastasi, 1976; Bertrand and Cebula, 1980). The new lines in turn were bases to the construction and application of mental tests.

The first acceptable individually administered general mental ability test was developed and applied by Alfred Binet and Theodore Simons in 1905 and the test was revised in 1908 and 1911 (Guilford, 1967; Anastasi, 1976).

Their attempt had given impetus to the explosion of test development and applications. However, the years after 1920 had brought about disagreement on the development, applications and interpretations of mental ability tests. Specially, issues on cultural differences attracted many psychologists. And they gave rise to different views. (Loevinger, 1943). One of those theories developed and which still is taken as fundamental theory is the General Mental Ability or Factor theory of Charles E. Spearman.

General mental ability or factor theory uses the method of factor analysis to identify a dominant common trait which has relatively high correlations with other traits. That common trait is said to be a general factor or trait and is labeled by Spearman as 'g'. The theory, thus defines mental ability tests as those instruments with tasks involving rote learning, routine skills or recall of specific information (Jensen, 1980).

Spearman denoted the basic principle which applies the above definition of mental ability is the 'principle of neogenesis (Raven, 1961). This principle has two elements- eduction and reproduction, which He meant perceiving relationships, inducing the general from the particular, and deducing the particular from the general (Jensen, 1980). In other words noegenesis is inductive or inventive as contrasted with rule-applying behavior which works in other approaches of mental test development.

As mentioned earlier, there is no single agreed upon definition and approach to mental ability and thus to its measurement techniques. However, there are certain agreed features of mental ability which are true for all theories including Spearman's theory of general mental ability. The features are that, mental ability is the product of both genetic and environmental experiences; there are large differences between individuals in mental ability, and, mental ability is multi-dimensional. In light of these features, mental ability tests can be explained through maximal performance tests in which the testee attempts to make the highest possible score. (Cronbach, 1970; Anastasi, 1976; Brown, 1983).

According to Kolesnik (1963) and Wiersma and Juris (1985), mental ability tests in general are applied

- to help placement decisions
- to provide a context for interpreting achievement performance
- to identify talents and skills
- to predict educational and occupational success
- to group individuals with similar levels of mental ability
- to show experi ental differences in terms of individual, group and cultural bases.

In applying general mental ability tests for the above mentioned purposes, genetic factors are assumed to be given

much emphasis than cultural factors (Jensen, 1980), and therefore, refinements of theories of general mental ability and improvements of its instruments are obtainable through cross-cultural applications (Vernon, 1965). However, a major controversy in the cross-cultural application of the instruments is the development of mental ability tests which serve the needed purpose without cultural bias. As a result, psychologists started to develop 'culture-fair' mental tests. These tests are claimed to measure general mental ability revealing genetic differences irrespective of cultural bias.

One of those mental ability tests with the above mentioned features is the Raven's Standard Progressive Matrices Test on which much research has been carried out in European, African and Asian countries (Croman & Budoff, 1974; Anastasi, 1976; Jensen, 1980; Dillom & others, 1981; Powers & others, 1986). The test is based on Spearman's principle of noegenesis and is said to reflect General Factor Theory. Below are given the history of development, cross-cultural applications, and the psychometric characteristics of the Raven's tests in general and the Raven's Standard Progressive Matrices Test in particular.

2.2. Raven's Standard Progressive Matrices Test

'Culture-fair' tests of general mental ability must

either reflect cultural universals or involve purely abstract reasoning (Brown, 1983). A typical 'culture-fair' non-verbal test which measures 'g' using items of abstract reasoning is the Raven's Standard Progressive Matrices Test.

J.C. Raven, a British Psychologist, developed the first series of matrices tests in 1938 in collaboration with Lionel C. Penrose, a British geneticist, when they were working together with mentally defective people at colchester institution in Great Britain. Raven, following Spearman's principles of noegensis, desired to measure immediate capacities for observation, clear thinking and the ability to perceive relationships (Raven, 1961; Cronbach, 1970). The test was utilized as a principal instrument to classify the British army during second world war (Cronbach, 1970). After the publication of the first series in 1938, the Raven's Progressive Matrices Test has been published in three forms.

a. Raven's Coloured Progressive Matrices Test, Sets A, Ab and B (CPM).

b. Raven's Advanced Progressive Matrices Test, Sets 1 and 11 (APM).

c. Raven's Standard Progressive Matrices Test, Sets A, B, C, D and E (SPM).

The coloured Progressive Matrices Test is designed to be used with young children, old people, and in anthropological and clinical research interests. The Advanced Progressive Matrices Test is designed for determining the intellectual ability of people whose age is over eleven and whose ability is average or more than average (Raven, 1961).

The Standard Progressive Matrices Test, hence forth SPM, in Raven's words (1961)

> ... is a test of a person's capacity at the time of the test to apprehend meaningless figures presented for his observation, see the relations between them, conceive the nature of the figure completing each system of relations presented, and, by so doing, develop a systematic method of reasoning.

The test comprises five sets - A, B, C, D and E - each with twelve items and a total of 60 problems. As the author claims the test works for every one who is six years old or above irrespective of nationality, culture, religion, education, academic ability and sex. Manual, scoring sheet and scoring key are available with the test booklet to make easy the administration of the test even by oneself.

The purposes of the test are not different from the general uses of mental ability tests mentioned before. As different studies show the test is applied for clinical, genetic and anthropological studies in addition to its use for comparisons on different bases.

2.2.1. The Culture-Fairness of SPM

The author claims that SPM is developed on the basis of the following rationals

1. The test is non-verbal which cannot be affected by language, reading, test content and speed. No environmental or sub-cultural factors affect performance. The tasks need 'figure-analogy' and the subject is directed to select a particular design which complets the missing part in the given pattern.

2. The test is not a test of 'general intelligence' by itself but a test of observation and clear thinking.

3. The test produces about similar mean scores for different sub-groups.

4. The test measures a similar construct for different sub-cultures.

5. The test predicts equally for different groups and individuals.

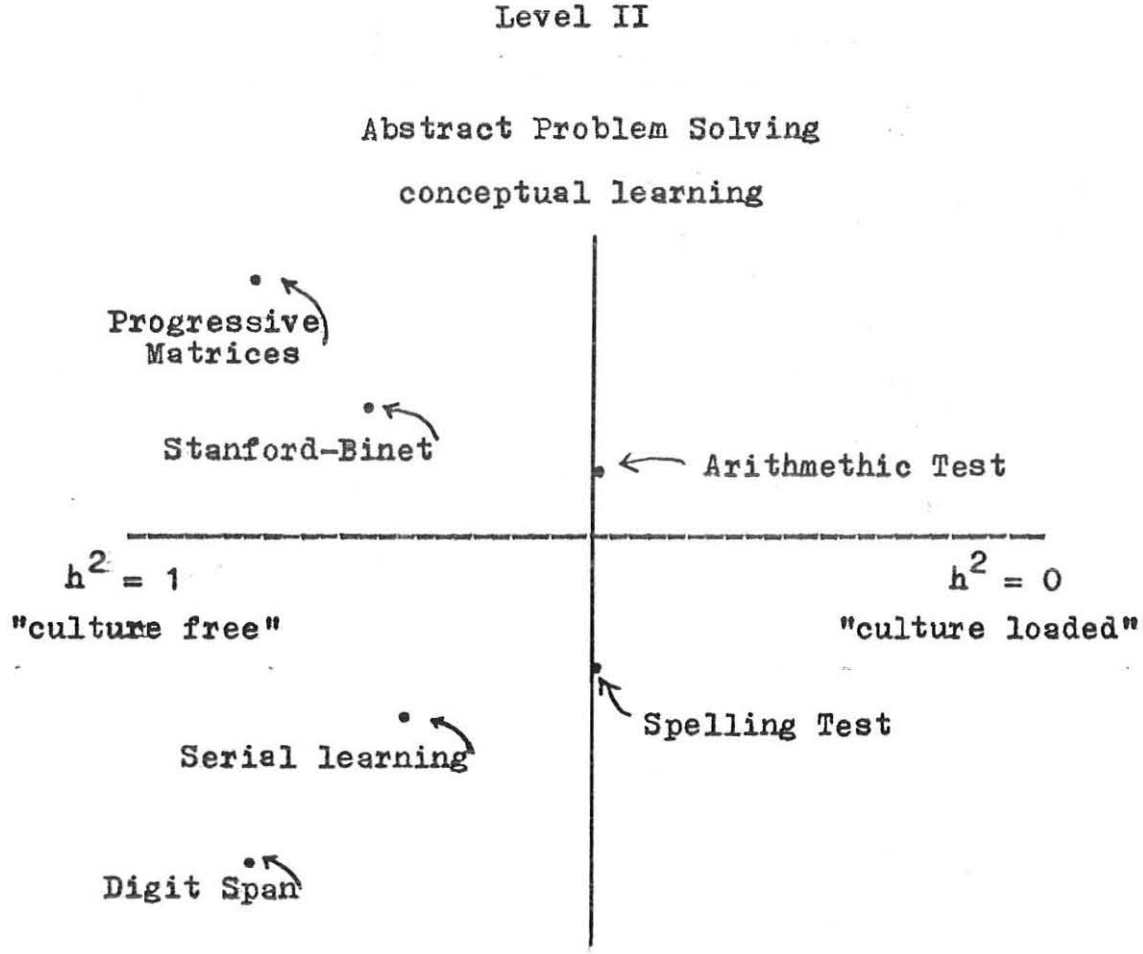
6. The test measures genetic differences in mental ability or innate ability.

Jensen (1970, cited in Dockrell) in his article about

intelligence, indicated how SPM is a pure measure of 'g' and with less cultural loadings. He used two-dimensional space (figure - 1). The horizontal axis is culture-load dimension and the vertical axis is complexity dimension. SPM is located in the fourth quadrant where the cultural-load is very low and where the complexity is in measuring abstract problem solving and conceptual learning. A significant implication from his hypothetical explanation is that there is little or no effect of environmental influence in the scores of SPM. Kelingelhofer (1967), Tulkin & New brough (1968), Wober (1969) and Cronbach (1970) lent support to what was explained by Jensen in that the SPM is less dependent on class culture, education and experience (Jensen, 1969; Cronbach, 1970). Anastasi (1976), however, is against Tulkin & Newbrough, Wober, Jensen & Cronbach. Because, she argues, it is unlikely for any single test designed to fully meet these requirements across a wide range of cultures.

Raven claims that SPM is constructed on a priori assumption that the items can measure the ability to apprehend and perceive figures (Spearman's principle of relations), the ability to see relations between figures (Spearman's principle of eduction), and the ability to conceive the correlative figures completing the systems of relations presented (Spearman's eduction of correlates) (MMYB, 1953). Factor analytic studies support Raven's

Figure 1. The two dimensional space required for comprehending social class differences in performance tests of intelligence, learning ability, and scholastic achievement. The location of the various 'tests' are hypothetical



Source: A.R. Jensen. 'Hierarchical Theories of Mental Ability' cited in W.B. Dockrel (1970) On Intelligence. p. 154.

claim and clearly put how Spearman's 'g' is measurable in a pure form using SPM (Cronbach, 1970; Anastasi, 1976; Jensen and others, 1988).

SPM has items (matrices) which are geometric networks having logical relations in them. They cover from simple to complex visual forms. There is a gap in each stem to which six or eight alternatives are given to choose from and to complete the gap in the stem. The patterns in each stem are different. In some tasks, the principle is to find a missing part from left to right, and in some others it is to find a part from top to bottom. Nevertheless, presentation of items is similar in all the sixty items. Since the relations within each matrix is more than one mode of analysis and synthesis each five set is progressively graded in difficulty both within and between each set. Therefore, item difficulty increases from item A_1 to item A_5 and from part A to part E. It is this quality of SPM that makes it helpful for the purposes stated by the author in general words, as 'from infancy to maturity and 'from the retarded and disturbed to the gifted and normal' (Raven, 1961).

Studies carried out to investigate SPM, particularly the nature of the items, concluded that the test with all its characteristics constitute a measure of general mental ability or fluid 'g' (Dillon & others, 1981). Against such presentation Keating (1978) support the test if termed as

a test of non-verbal reasoning ability than a test of general mental ability because, it requires choosing the correct figures in order to complete a matrix. Similar conclusions were reached by MacArthur & others (1964) Schnell and Louis (1967), Fracchia & others (1969) and Powers and others (1986).

2.2.2. Reliability and Validity Studies on SPM

A number of investigators in non-western cultures applied SPM to investigate its reliability and validity in a group different from its origin. The investigations are based on gender, ethnicity, academic level, socioeconomic status and other environmental factors.

Raven (1961) said that, the scale has a re-test reliability varying with age from 0.83 to 0.93 ($P < 0.02$) and found to have a 'g' saturation of 0.82 for British samples. The reliability of the test, according to him, goes with maturity which is related with relatively constant scores in the test. Rimoldi (1948) had examined the factorial composition of the test and whether or not the variance obtained is attributable to 'g' only. He used a random sample of school children (N = 38) whose mean age was 11.4 years. He found that the five sets of SPM are highly correlated to each other and the test is loaded in several factors in addition to a common factor, i.e. 'g'. In a complete review of SPM in the fourth Mental Measurements

Year Book (1953) the latest reliability to the time was 0.88.

Yates (1961) used point-biserial correlations of each item with total socres obtained in SPM and indicated that the test would be highly reliable if sampling is highly efficient. He reported also similar findings were obtained by Raven (1961).

Baraheni (1974) used Iranian children (N = 4561) to determine the reliability of SPM and to explore the possibility of using the test as a measure of general mental ability in Iran. The reliability coefficients obtained for males between the ages 9 - 18 ranged from 0.90 to 0.95 and for females of the same age range the coefficients were between 0.86 to 0.95. Baraheni found the total split-half reliability coefficients for both sexes in the same age and obtained between 0.89 to 0.95. Baraheni concluded that SPM is a promising instrument for use with Iranian students except for the significant differences he obtained between the sexes.

SPM was also used in African cultures. MacArthur and others (1964) reported in a survey that the test was administered in Congo, East Africa, and Zambia, (the then Southern Rhodesia) particularly, and high reliability (r = .85) was found in the test. Klingelhofer (1967) pointed that SPM can be used for psychometric research on the African continent, particularly in South Africa, West Africa, Zaire,

Zambia and Uganda. He also showed that the test is a relatively pure measure of Spearman's general factor 'g'. Another African study was done by Wober (1969). He had administered the test among Nigerian factory workers (N = 86) and found a re-test reliability coefficient of .58.

Factors which could possibly influence the reliability of the test are given as age (Raven,1961) and sampling methods (Yates,, 1961). Lowest reliability can be obtained if the test is administred to either very young or very old people. Sampling, which is randomly chosen, and if it is representative enough, it results in high reliability in the test. Physical or mental illness do not produce decreasing effects (Raven, 1961).

The validity of SPM was also investigated in several studies. Some studies obtained high and some others obtained low validity coefficients. Westby (1953), in his complete review of the test in the fourth Mental Measurements Year Book put that, inspite of homogenity, there is low general factor between the sets which check against very high validity.

Keehn and Prothro (1955), in examining the predictive efficiency of non-verbal tests in Lebanon, used randomly selected subjects (n = 206) and applied SPM (1938) to obtain a single factor of .75. They found out that the test is correlated with either academic marks or teachers'

judgements of intelligence slightly for grades two, three and four (r = 0.12, 0. 12, 0.13 respectively where r is significant at .01 level).

In reviewing researches done on Wechsler Intelligence Scale for children , Littell (1960) found its correlation with SPM. SPM was correlated with the verbal scale (r = .69), with the performance scale (r = .69) and with the full scale (r = .75).

In African studies, McArthur and his colleagues (1964) reported concurrent validity of SPM to be 0.30 in their review on the studies of SPM in Congo, East African and Zambia. Wober (1969) for his Nigerian sample (N = 86) determined the validity of the test to be 0.28, and concluded that the test is not directly related to the amount of education which one gets.

Cronbach (1970), emphasizing the narrow sample of abilities represented in the test, gave validity evidence from the studies of Meyers, Attwell and Orpet (1968). The investigators correlated SPM scores obtained during kindergarten with achievement test score of the same subjects in fifth grade (r = 0.39). SPM also used to predict language ability in the same grade (r = 0.35). Cronbach in his review of studies showed that, Barett has found a correlation of .57 with Wechsler Intelligence Scale for children; and concluded that the test is more related with verbal ability than performance.

Matrix scores are not also much related with Piagetian types of tasks (Goodnow&Bethons, 1966, cited in Cronbach, 1970) and correlations were found to below .25.

Mclaurin and Farrar (1973) also compared SPM scores with other intelligence scores (N = 202). They found no evidence for the practical value of SPM for its substantial predictive validity and the low coefficient of validity in predicting academic success from the scores of SPM had raised doubts (r = 0.21).

The Iranian study by Baraheni (1974) on students between the grades 3 to 9 (N = 4561) resulted in validity coefficients of the test between the ranges .24 to .61 ($P < 0.01$). The correlations were found between SPM scores and average school marks and the current socioeconomic status of the subjects.

Vincent and Cox (1974), in assessing the viability of SPM in the United States of America, took a sample from the general adult population (N = 380) and administered the test. Low coefficient of validity (r = .36) was found between SPM and education level. Their finding lent support to the findings of Jensen (1969), Wober (1969) and Cronbach (1970).

Anastasi (1976) stated doubts about the validity of the test in non-European cultures. Her doubts rest specially upon testing groups with very dissimilar backgrounds. Education and practice are major elements in affecting the

validity of the test as she explained. Anastasi added that the items of SPM can be grouped as spatial aptitude, inductive reasoning and perceptual accuracy which are in general said to be narrow samples of abilities. Correlations of the test with verbal and performance tests range betwen 0.70 to 0.90 but it can be said that there is more relation with performance tests than with verbal tests. This assertion is against the finding of Barret (cited in Cronbach, 1970). SPM in relation to academic achievement showed lower predictive validity coefficients than those obtained using verbal intelligence tests (Croman and Budoff, 1974).

Powers and others (1986), having the objective of examining the predictive validity of SPM, conducted a study with sixth-and seventh-grade students in America. They took 426 subjects (225 males and 201 females) from four elementary schools and a junior high school. An examination of the validity coefficients revealed that all were statistically significant ($p < .05$). Validity coefficients ranged from 0.34 to 0.60 for sixth-grade and the coefficients from 0.45 to 0.57 for seventh-grade. Grade level seemed to affect the scores in that the correlations for seventh grade were higher than sixth grade. They claim in their findings that the range and magnitude of the validity coefficients were similar with the validities reported (ranging from .26 to .61) in the 1983 manual of the test.

Therefore, the study indicated the moderate predictive validity of SPM which may vary upto .26 depending on sex, grade or academic criterion.

2.2.3. Norms, Administration and Scoring of SPM

SPM has no norms for individual administration for age fourteen and above as stated in the ninth Mental Measurements Year Book (1985). As no general revision has been made except in the 1983 manual, the same test booklet with a change in one item and order of items, and the same separate record form are used. For interpretation of scores on SPM Test, the following grades are given in the 1961 manual I. intellectually superior ($\geq 95^{th}$ percentile); II. definitely above the average intellectual capacity ($\geq 75^{th}$ percentile) III. intellectually average (25^{th} - 75^{th} percentile); IV. definitely below average in intellectual capacity ($\leq 25^{th}$ percentile); V. intellectually defective ($\leq 5^{th}$ percentile). The 1961 manual gives norms for individual test, the self-administered or group test for children and adults.

For children, the working percentile points of individual test were calculated from the natural scores of 735 children, and for self administered or group test working percentiles were calculated from the natural scores of 1,407 children. For adults, 3,665 militiamen and 2,192 civilians were tested to produce working percentile points (Raven, 1961). In general the percentile norms on British

samples are provided for each half-year interval between eight and fourteen years and for each five-year interval between 20-65 years. Rimoldi (cited in Anastasi, 1976) obtained similar percentile norms for Argentinian sample (N = 1680). Cronbach (1970) states that the test is poorly standardized even in its native country.

A major advantage in using SPM is its easy administration for both the tester and the testee. No verbal description is given. The test can be administered individually or in group. Materials needed are a test booklet, a record form and a pencil for a subject. Demonstration can be done using item A. 1. and then little oral instruction makes smooth testing. Further more, there is no time pressure upon the testee. The effect of the untimed nature of the test was examined by Schenell and Louis (1967) and their result suggested that the use of time may be a variable to consider when using the SPM. However, Raven's rationale not to fix the time except for some instances (45 mintues) is that as an untimed 'capacity' test and even as a 20-minute 'speed' or 'effeciency ' test, the results have been found to be more reliable and psychologically valid than one might expect from sixty problems arranged in five sets of overlapping difficulty (Raven, 1961).

Scoring can be done by hand or by machine. The record form is made standard so that scoring can be done using stencil keys for rapid marking. As Raven (1961) has put

it, a person's score on the scale is the total number of problems he solves correctly when he is allowed to work quietly through the series from the beginning to the end. Interpretations of scores are advisable to be based on similar age group to show relative positions of test takers. The author claims that the two assumptions (the development of intellectual capacity is necessarily uniform; and at maturity the capacity is necessarily distributed symmetrically throughout the general population (Raven, 1961) of the test would be fulfilled if age norms are used during interpretations of scores.

2.3. Cross-Cultural Studies Using SPM

Cross-cultural studies are conducted usually to examine individual differences, in particular, and cultural differences in general. As mentioned earlier, studies on individual differences are mostly based on differences in academic achievement, gender, personality, age, residence, ... etc. And cultural differences are considered between large social groups as a whole or within social categories of a large cultural group.

Therefore a test which attempts to control the effect of cultural bias is said to be 'culture-fair' if it results in nonsignificant differences between mean scores of different subgroups; if it does measure similar constructs for different subcultures; and if it predicts equally for

different subgroups (Brown, 1983; Nitko, 1983; Meherns & Lehamann, 1984).

However, psychologists argue on the nature of 'culture-fair' tests. They feel that the tests are somehow illusory because the items even if they are non-verbal, it is difficult to make them free from the control of cultural variables.

Therefore attempts in the construction of 'culture-fair' tests are concentrated either on their betterment or in finding sources of errors in performance in various subgroups so that to produce effective instrument; and both directions use the existing 'culture-fair' tests. SPM, as a suitable 'culture-fair' non-verbal measure of general mental ability, has been extensively used cross-culturally to conduct behavioral researches. The studies considered how various factors are related with general mental ability. Significant cultural factors such as socioeconomic status, academic achievement, sex, ... etc. are usually taken to examine their effect on the test and if the test can be used for different purposes.

2.3.1. Socioeconomic Status (SES) differences on SPM

Cross-cultural studies paid much attention to the investigation of SPM in relation to SES. The investigations have a principal aim of collecting evidence for the culture-fairness of the test interms of differences in social-

class culture.

Sociologists agree that there are at least two or three distinguishable levels or status in any given society except in those which are culturally backward or which are composed from more or less similar socioeconomic characteristics (Rodman, 1968). However, disagreements rest upon the exact character of the levels or status and the exact distinction between the levels or status.

By status, it means in general, the rank which an individual occupies in terms of given gross indicators. Most recent researchers use status bascially as a foundation for a social class which nominally means the reward (possessions, esteem, money, education, etc...) and position of an individual in the power structure of the society. Gradual developments result in the establishment of norms which are standard and specific to the social unit out of the composition of those individuals with the same or similar status. Weber (cited in Rodman, 1968) considered property, power and prestige as bases on which hierarchies are created in any society. To him the way in which scarce values (in terms of property, power and prestige) are allocated determines one's social status which reflects his or her class culture.

Rodman (1968), in his article on class culture, states that a separate class of people in a society would develop

a distinctive class culture or way of life. Therefore in understanding SES, class culture is a useful concept. If class culture is a representation of the whole subculture which includes both material & spritual possessions, then every class is said to have its own subculture. However, not all subcultures practiced in a given social class are fully distinct from subcultures of other social-class. Nevertheless, all subcultural differences arise mainly from the practices made on environmental factors.

Studies based on SES are usually questioned how they controlled boundaries of each status they assume to exist, how they determine status and how social mobility is controlled. To tackle this problem, recent research techniques have been developed. Considering the powerful and dynamic nature of SES as a variable in social differentiation, the use of combined indices, such as in Warner - Meeker - Eells Scale (1949) and in Hollingshead's index (1956), has come to reality in both boundary formation and controlling of at least current social mobility (Hopkins & Stanley, 1981).

Psychologists, however, agree on the influence of SES on mental ability and use scales to determine SES, they do not converge to a point on the differences resulted from applying SPM as a cross-cultural test. As Thorndike (1968) had put, the presence of these differences is unquestioned, but it is the source that matters. A factor to be investigated

as a source can be cultural influence in general and sub-culture in particular.

Tulkin and Newbrough (1968) took 356 fifth-and sixth-grade students from a Suburban Maryland school system. The subjects were classified in two SES groups-high and low; two racial groups - white and black, and two sex groups - male and female. Their objective was to determine whether or not similar social and cultural effects could be found on SPM (1956).

They used a questionnaire on home and family characteristics in order to determine SES of subjects. They used a three-way analysis of variance which yielded significant main effects on SES and no interaction effect. Their findings showed that the higher social class and the white subjects obtained significantly higher scores on SPM, and significant variance attributable to SES was found for all cross comparisons. The lower-class subjects scored significantly below the upper-class subjects. In general, Tulkin and Newbrough, concluded that the SPM is not 'culture-free' but still more 'culture-fair' than other tests used (Large-Thorndike - Level Three and Iowa Test of Basic skills).

The SPM had been correlated with cultural measures and the figures showed very low but significant correlations. The highest correlation found significant below .01 level was for white lower class subjects ($r = .33$). The other

correlations were below .20. However in general they reported that SES contributed more variance than race.

Jensen (1969) in his article on the heritability of mental ability gave less emphasis to the contribution of cultural influences. He identified SES contextually as a continuum within racial groups. One of the contributions from studies on SES is that, the mental ability of children is highly correlated with SES of their parents, and specifically correlated with occupational status of fathers. Previous and later studies support the idea that SES has very low correlations with general mental ability (Tulkin and Newbrough, 1968).

Handel (1973) had the objective of establishing the developmental properties of ability measures. He took four samples - Sample A (N = 557 boys from grades 7-11), sample B (N = 127 boys from grade 7), sample C (N = 950, 440 boys and 510 girls from grade 7), sample D (N = 161, 77 boys and 84 girls from grade 7) - and applied SPM (1960) to determine general mental ability. The results were taken as criterion-measures to examine the validity of Dominoes Test (D-48) as a non-verbal measure of general mental ability among adolescents in Israel. Handel found that the two non-verbal tests related significantly to a gross measure of SES (i.e. the number of persons living per room in subjects' home). The measure as applied to sample C,

correlated -.28 and -.27 with the D-48 and SPM respectively indicating that the differences between the SES groups in SPM scores are very low. This finding lent support to Tulkin & Newbrough (1958).

Bart and Others (1986) made comparisons between low SES and middle SES subjects using SPM Test (1958, parts A to D). SES was measured using Gough's Home Index (1970). The result on the test revealed that both were significantly similar. Their findings support reports by Tulkin & Newbrough (1968), Jensen (1969) and Handel (1973).

Townsend (1982) in examining the relationship between performance on SPM and other types of paired - associate tasks took 10-11 year old children (N = 227) and formed low, middle and upper SES groups. Scores on the SPM were not that much different for the two SES groups. The groups demonstrated undistinguishable performance on the test.

In general, researches on the relationship between SPM and SES reported similar findings that differences between SES group are very small. In some studies, however, the difference is observed significant.

2.3.2. Grade level differences on SPM

SPM has the assumption that education and related experiences have very little or no effect on scores.

Studies attempted to investigate how far this assumption works in school conditions. With regard to the assumption the test is usually investigated in terms of grade levels and or academic achievement by a number of investigators (Mclaurin, & Farrar, 1973). Studies support the capacity of the test in predicting academic achievement but if the academic achievement itself is measured by objective tests.

Keehn and Prothro (1955) had examined the predictive efficiency of non-verbal tests and gathered evidence against the effectiveness of predictors of school grades in Lebanon. They took 206 students and applied Cattell's culture free tests (1944), SPM (1938), Dominoes Test (D-48, 1952) and Number-Series Test. Their finding revealed that SPM is slightly correlated with academic marks ($r = .12, .12, .13$ for grades 4, 3, and 2 respectively). All were significant at .01 level. Their finding was supported by MacArthur & others (1964) Who compared SPM scores with scores in the standard-six examination. The comparisons produced lower index of associations ($r = .25$).

Klingelhofer (1967) in his study of the Tanzanian sample ($N = 3692$) of students from 31 schools, had the objective to secure some descriptive information about secondary school pupils and to relate performance of the SPM to other characteristics of the examinee (Sex, age, tribe and educational level). He found that differences

in mean$_{\Lambda}^{SPM}$ level to be associated with other factors but independent of grade level. It means that SPM scores were not affected by level of education. The significant differences in mean level of SPM scores exist between Asians and Africans when the groups are compared within tribe and sex groupings.

In the study by Tulkin & Newbrough (1968), the relationship between SPM scores and achievement test (Vocabulary, Reading, Language, Work-study and Arrithemtic) was examined. Most of the correlations obtained are between .25 to .41 for white samples and between .14 to .40 for Negro samples. All were significantly different from Zero except for reading in the Negro high SES. The magnitudes of the correlations showed that SPM was a moderate predictor of academic achievement in general for the total sample (N = 356). The findings of Tulkin & Newbrough were against Keehn& Prothro (1955) and support the findings of Klingelhofer (1968).

The study of Wober (1969) focused on clarifying factors affecting African's scores on general mental ability (N = 86). He administered SPM twice and found its correlation with education to be low (r = .28 and .23 respectively). He concluded that ability to gain in matrices test is not related to amount of education. Similar observations are given by Tulkin and Newbrough (1968),

Jensen (1969) and Cronbach (1970).

The predictive nature of SPM was investigated in comparison to Lorge-Thorndike Intelligence Test and Wechsler Intelligence scale for children (Purl & Curtis, 1970). The predictive power of these measures with respect to a number of achievement measures was examined in a sample of school children (N = 605). Results indicated that SPM is more predictive of verbal abilities for females than for males. Though it provided substantial prediction for all other groups in the majority of cases the SPM was found poor in predicting reading and arithmetic achievement for Sixth grades than predicting the same achievement tests for first and second graders. This has the implication that the predictive capacity of SPM was more to verbal than to non-verbal a bility specially for females who are better in language ability at these developmental stages (Piaget, 1964). In their study, the Lorge-Thorndike Intelligence Test was found superior to the SPM as a predictor with all groups.

Cronbach (1970) explains achievement test as useful primarily to examine an individual's success in past and in future study. Brown (1983) has similar view in explaining the similarity between achievement and mental ability tests that both are maximal performance tests in which the test takers attempt to make the highest possible score and

success can be decided. In light of this convention, Cronbach (1970) states the relationship between SPM as an abstract nonverbal measure and academic achievement. Their relationship resulted in calling of attention to pupils with the ability to direct attention, process information, and regulate thought, but with lesser ability in language. His explanation is against the findings of Purl & Curtis (1970). Cronbach put evidence for his explanation from the report of Meyers, Attwell & Orpet (cited in Cronboch, 1970) that SPM test during kindergarten predicted achievement test score in the fifth grade with a correlation of .39 and language ability in the same grade with a correlation of .35.

Jensen has his own views with regard to the relationship between education (academic achievement) and scores on SPM Test. His views rest upon the contention that objective evidence of culture bias in education could account little by itself. But it has to be related with other factors such as race and SES (Jensen, 1972). Studies on SPM Test and its relation with educational experience however, report differently: with minimized effect of SES and race the relationships found between education and SPM Test are small but significant (Thorndike, 1968).

Similarly, Mclaurin and Farrar (1973) in comparing the validities of SPM (1938) and APM for IQ and GPA, they took

the GPA of 322 college students and concluded that there is no reliable evidence from the results of their study that SPM has practical value for the prediction of academic achievement. In comparison of the predictive capacity of SPM and APM they obtained correlations of .21 and .35 respectively.

Better predictive figures were obtained by Baraheni (1974) in his study of the Iranian Sample (N = 4561). Correlations varied between .24 and .61 and all were significant below .01 level. The correlations were all moderate except for the correlation for grade three (r = .24). Correlations were found to become greater in magnitude with grade levels increasing. It was on the basis of this result that Baraheni recommended SPM as an instrument with Iranian children. Stephen powers and others (1986) examined the predictive validity of SPM with a sample of 212 sixth and 214 seventh-grade students. Correlation coefficients between SPM and California Achievement Tests of (CAT) Reading, Language and Mathematics ranged from .34 to .50 for grade six and from .45 to .57 to grade-seven. Validity coefficients were all significant below .05 level. Correlations were higher for grade seven and increase from reading to mathematics. Their investigation led them to conclude that SPM has a moderate correlation with academic achievement which was similar to the conclusion made by Raven (1961).

2.3.3. Sex Differences on SPM

Differences between the sexes in scores of SPM are one of the major areas on which investigations have been made widely. Findings which led to generalizations about the differences are similar to those findings that used other general mental ability tests. Some investigators interpreted their study as indicators of significant differences between the sexes and others claimed that no significant sex differences existed. Investigators do use the hypothesis that sex differences are genetic differences and such differences would be in accord with a number of observed physical sex differences. Jensen (cited in Kamin, 1978) had the idea that boys are more vulnerable than girls to environmental influences, both physically and psychologically. Thorndike's (1968) idea is against Jensen's claim that there are some sex differences which appear with respect to specific types of test tasks. However, the differences are of modest size and appear to reflect considerable cultural effects rather than inherent differences.

In a study to secure descriptive information about secondary school pupils, Klingelhofer (1967) found non-significant relationship between SPM performance and sex for the total sample. Girls and boys in the same form and in the same group (i.e. African or Asian) earn equivalent mean SPM scores in general except in form 3 where African

girls' mean score is significantly greater than that of boys. Comparisons made between the means for Asian boys and girls reveal that the boys earn significantly higher mean SPM scores in grade-two and for all forms combined. In general Asian boys obtained higher mean scores in the test.

Sex difference was also studied in the investigation of the application of SPM to Iranian children. Results of the test revealed that the test measures consistently what it ought to measure. This evidence is collected in the determination of the reliability of the test. The coefficients vary between .88 to .95 for females and between .92 to .95 for males (Baraheni, 1974). Baraheni concluded about the difference between the sexes in that Iranian boys consistently did score higher on SPM than did Iranian girls. The differences between boys and girls were significant upto age 13, but decreased thereafter with the exception of age 16, at which the difference was again significant. A steady increase in the scores was observed, according to his report, at successive age levels. But in general he reached the conclusion that the magnitude of differences at some age levels was very small.

Powers and others (1986) in determining the predictive validity of SPM (1983) took samples from both sexes in grades-six and seven (N = 212 and 214 respectively). Sex differences in performance were not significant in both grade levels.

CHAPTER THREE

DESIGN OF THE STUDY

The purpose of the present study is to investigate the application of the Raven's Standard Progressive Matrices Test to Ethiopians with different socio-cultural background. Specifically it aims to examine whether or not there are relationships between the dependent variable - General mental ability - and the independent variable - Type of Schooling, Socioeconomic Status, Grade level and Sex.

Therefore, the study is a factorial type which deals with subjects' general mental ability in terms of two types of schooling, two types of SES groups, three academic levels and sex. Supplementary correlational analyses are used in order to see relationships between the dependent and the treatment variables.

3.1. Sampling Procedure

The target population of the study was students of grades seven, nine, and eleven in the selected schools of Addis Ababa. The total number of students in the schools was 5,177 (2760 male and 2417 female) in the respective grade levels. These grade levels were considered in the study because the students were assumed to react accordingly

to oral instruction during administration of SPM Test and the Index of Socioeconomic Characteristics (ISC).

Considering that there are -

a) high degree of homogenity in educational settings with each type of schooling (taken as stratum)

b) limitations in time, cost and available test materials (a few copies of Raven Standard Progressive Matrices Test were available)

c) minimum variances to be produced in using stratified random sapling procedure in estimation

a total sample of 600 students was taken for this study. It constituted about 11.6% of the total population of the selected schools in the respective grade levels. Stratified random sampling was utilized in all stages.

The following procedures were used in the selection of schools and subjects.

a) Schools

Three Government and two Non-Government schools participated in the study. The Government schools were selected randomly and the Non-Government Schools were selected purposely because of the fact that they have

relatively larger number of students than other similar schools.

b) Subjects

First, proportional allocations of sample size has been made to each type of school to each grade level and to each sex. The unit of proportion established to decide sample size was 0.1158972 (about 11.6%). The unit was the ratio between the determined total sample size (N = 600) and the total population of students in the considered types of schools.

Subjects were then selected randomly using student name lists and a four-digit random number table, Corresponding classroom roll numbers were registered till the fixed proportion of sample size was reached. Similar procedure was followed in all schools.

3.2. Data Collection

3.2.1. Instrumentation

Data were collected from the samples on general mental ability, socioeconomic status, and sex. The following instruments were used to collect the data.

a) General mental ability (M - ab)

Raven's Standard Progressive Matrices Test, SPM (1958)

was employed to measure general mental ability. It is a non-verbal 'culture-fair' test. It measures abstract reasoning, clear thinking, perception ability and identification of relationships between figures. The subjects were required to find a figure which fits the missing gap in the item pattern. The test has 60 items with either 6 or 8 choices. The items are geometric figures or patterns which are arranged in increasing level of difficulty. Normative data are unavailable about the test. The maximum obtainable score is 60.

The test was administered to thirty students in order to design administration, recording and scoring procedures. As a result oral instructions given in the test manual (1958) were translated into Amharic and were adapted to the situations in which they were to be utilized. The test booklets were obtained from the Testing Centre of Addis Ababa University. Half of them were original and the other half were electrostenciled. Response sheets were also electrostenciled and duplicated.

Split-half reliability in terms of odd and even parts and KR - 20 were computed and coefficients were found to be 0.98 and 0.97 respectively (see Appendix-1 &-2).

b) Socioeconomic status (SES)

An Index of Socioeconomic characteristics (ICS) was

adapted to quantify socioeconomic positions of subjects in terms of parental occupation and education level (see Appendix - 4). Father's or guardian's occupation and last education level completed were parts of the index.

The index was adapted from the Warner-Meeker-Eells scale and from Hollingshead's Two Factor Index (Hopkins and Stanley, 1981). The adapted index included eight categories in each gross indicator. The categories were taken from the Analytical Report on the Population of Addis Ababa (Central Statistics Authority, 1987) (see Appendix - 5).

Different arbitrary weights were given to each - 5 and 3 respectively - based on the relative magnitude of influence on SES. Various literature support maximum weight to be alloted to occupation (Jensen, 1980; Hopkins and Stanley, 1981). For instance in the Warner - Meeker - Eells Scale it is given a weight of 4 while in HollingShead's index it is given a weight of 7. For indicators such as education it is reasonable to give relatively lower weight since it has lower magnitude of influence on SES. Both scales (Warner-Meeker-Eells Scale and HollingShead's index) have given less weight to this indicator. It was the aggregate of the weighted scores that was taken for a subject to determine his or her SES group. The maximum obtainable score was 8 and the minimum was 64 since

categories for each were arranged in decreasing order (1 to 8). The average score (35) was taken as a cutoff score to assign a subject into either upper or lower SES group.

In order to decide an easier and reliable way of obtaining data on SES, the index was administered to 30 students who represented the characteristics of the total sample.

3.2.2. Procedures of Data Collection

The Raven Test was first administered in all schools. Three test specialists from the Testing Center of AAU administered the test. They followed uniform procedures in administration as designed previously.

During the administration of the test, the subjects were first given practice on the first two items. The practice helped them to understand each item and how to give responses. Their responses for the two practice items were checked and then they were told to write the beginning time on the response sheet. Working time was limitless. Scoring was done in the Testing Center. A subject's response sheet was found incomplete and was excluded.

The Index of Socioeconomic characteristics was administered by four assistants and the researcher in the form of interview. Each subject told his or her father's or guardian's occupation and education level completed.

All subjects completed the index. Scoring was done by two assistants. Data on sex and age were collected on this index.

3.3. Statistical Procedures

3.3.1. Variables

a) General Mental ability (Y) is the dependent variable.

The independent variables are

a) Type of schooling (X_1)
b) Socioeconomic status (X_2)
c) Grade level (X_3)
d) Sex (X_4)

3.3.2. Methods of Analysis

First t-tests were computed to determine if there are statistically significant differences between the mean general mental ability scores of

a) Government and Non-Government schools
b) Upper and lower SES groups
c) Male and female subjects,

and a one-way analysis of variance was made to determine whether there is a statistically significant difference between the mean general mental ability scores of grades

seven, nine and eleven subjects.

Main and interaction effects of the independent variables upon the dependent variable were examined using factorial designs of different levels. Therefore analyses of variance were employed for SPM Test in terms of

a) Type of schooling and SES
b) Type of schooling and Grade level
c) Type of schooling and Sex
d) SES and Grade level
e) SES and Sex
f) Grade level and Sex
g) Type of Schooling, SES, Sex and Grade level

In addition, supplementary analysis using correlations (simple, multiple and partial) was done in order to examine relationships between the dependent and the treatment variables. Dummy codings were utilized as follows

a) '1' for Non-Government Schools
   '0' for Government Schools

b) '1' for male Subjects
   '0' for female Subjects.

Preliminary statistics (Means and Standard deviations) were computed for the total sample, for each type of school, for each SES group, for each grade level and for each sex. Alpha value of .05 was used for all significance tests in the study.

CHAPTER FOUR

RESULTS OF THE STUDY

The major objective of the present study is to examine the applicability of SPM Test (1958) to Ethiopian subjects with different socio-cultural experience. In this chapter first the collected data on the independent variables will be presented in relation to the four specific questions stated in chapter one and secondly interpretations will be given.

4.1. Subjects' Characteristics

Out of the total sample (N = 599), 319 subjects were male (53.26%) while 280 subjects were female (46.74%). 93.99% of the subjects were between 13 and 18 years of age. The mean and median ages for the total sample were 15.17 and 12.93 years respectively (SD = 1.57). In the Government schools age ranges between 11 and 22 while for the Non-Government schools the range is between 11 and 18. In terms of Piaget's developmental stages the subjects are in the stage of Formal-operational stage which implies that their intellectual capacity is at the stage in which the ability to reason, to identify relationships and the use of clear thinking prevails. Further, all the subjects completed first-semester lessons given in the academic year of 1991-1992 in their respective grade levels.

Table - 1

Proportional Sample Size taken from each type of school

by grade level and sex

(N = 599)

Type of Schooling	Grade 7				Grade 9				Grade 11				Totals	
	M	F	Total	%	M	F	Total	%	M	F	Total	%		%
Government	22	20	42	7.01	138	120	258	43.07	115	100	215	35.89	515	85.97
Non-Government	14	14	28	4.68	17	15	32	5.34	13	11	24	4.01	84	14.03
Total	36	34	70	11.69	155	135	190	48.41	128	111	239	39.90	599	100.00

Table - 2

SES characteristics and age distributions

by Type of School

(N = 599)

Characteristics	Government Schools	Non-Government Schools	Totals	%
SES				
Upper	204	66	270	45.08
Lower	311	18	329	54.92
Total	515	84	599	100.00
Age (in years)				
< 13	18	10	28	4.67
13 - 15	268	49	317	52.92
16 - 18	221	25	246	41.07
> 18,	8	-	8	1.34
Total	515	84	599	100.00

ISC (SD = 15.20)

Age (SD = 1.57)

4.2. SPM Test Results

The maximum score obtained in the SPM Test was 57 and the minimum was 8. The mean score of the total sample is 34.01 (SD = 13.29). Means and Standard deviations for each group in the treatment variables are presented

in Table - 3.

The standard deviation of the SPM Test Score for the Government schools is about 1.7 times greater than the standard deviation of the Non-Government schools. Though the difference between the standard deviations of upper and lower SES groups is small (.65), the upper SES subjects obtained a mean score larger than the mean score of lower SES subjects. Mean scores increase and standard deviations decrease from grade seven to eleven though differences in standard deviations are small.

Table - 3

Mean scores and standard deviations on SPM Test by Type of Schooling, SES, Sex and Grade level

(N = 599)

Variables	N	$\bar{X}$	SD
Type of Schooling			
Government	515	32.42	13.34
Non-Government	84	43.74	7.74
SES			
Upper	270	37.99	12.44
Lower	329	30.74	13.09
Sex			
Male	319	34.95	13.46
Female	280	32.93	13.04
Grade level			
Grade 7	70	28.51	14.75
Grade 9	290	34.10	13.41
Grade 11	239	35.50	12.36

NOTE - Maximum Possible (raw) score in the SPM Test (for an individual subject) = 60.

Mean differences between the sub-groups under each independent variable were determined using t-test. The pooled variance t model was applied (Minkle, Wiersma & Juris, 1979), i.e.

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\left[\frac{(n_1 - 1)S_1^2 + (n_2-1)S_2^2}{n_1 + n_2 - 2}\right]\frac{1}{n_1} + \frac{1}{n_2}}}$$

Where $\bar{x}_1$ = mean score of sub-group$_1$

$\bar{x}_2$ = mean score of sub-group$_2$

n_1 = sample size of sub-group$_1$

n_2 = sample size of sub-group$_2$

S_1^2 = variance of sub-group$_1$

S_2^2 = variance of sub-group$_2$

The tests yielded highly significant mean differences between Government and Non-Government Schools ($t = -7.56$) and between upper and lower SES groups ($t = 6.896$) even at .001 level of significance ($t \pm 3.291$, df 597). The sex groups revealed nonsignificant mean score difference at .05 level of significance ($t \pm 1.960 > 1.859$, df 597). The t-tests indicated that the larger mean scores for Non-Government school subjects, upper SES subjects and male subjects are not the result of chance factors or sampling fluctuations.

A one-way analysis of variance (see Table - 4) also

yielded a significant mean difference between the three grade levels even at .001 level of significance ($.999F_{2,596}$= 7.00) which implies that the differences in mean scores are not affected by the occurrence of chance factors and sampling error.

Table - 4

One-way Summary ANOVA –SPM Test Scofes by Grade levels

Source of Variation	Sum of Squares	Degrees of freedom	Mean Square	F
Between grade levels	2701.33	2	1350.67	7.82***
Within grade levels	102972.64	596	172.77	
Total	105673.97	598		

***significant < .001

Pair-wise comparison using Scheffe method was made to determine which pairs or combinations of means are equal in the grade levels. Scheffe comparison was selected since it handles fewer statistically significant differences (Hinkle, Wirsma & Juris, 1979). The test statistic for the comparison after contrasts is established using the formula:

$$F = \frac{(\sum c_j \bar{x}_j)^2}{(MS_W)\left[\sum (c_j^2/n_j)\right]}$$

Where c_j = Coefficients or contrasts

$\bar{x}_j$ = Group mean

MS_W = Mean square error

n_j = Sample size

The test applied (F_{cv}) was computed using the formula:

$$F_{cv} = (K - 1)\ (F_{cv_{(.05)}})$$

Where k = number of groups

The comparisons indicated significant mean differences between grades 7 and 9 and between grades 7 and 11 (see Table - 5 and Appendix - 6-1) at .05 level of significance ($.95\ F_{2,596} = 6.02$). But there is no mean difference between grades 9 and 11 which is statistically meaningful. Therefore the mean difference between grade 7 and the others

Table - 5

Pair-wise mean comparisons between Grades 7, 9 and 11

Groups	F
Grade 7 and 9	10.199*
Grade 7 and 11	15.312*
Grade 9 and 11	1.49

*Significant < .05 ($F_{cv_{(.05)}}$ = 6.02 for df = 2,598)

is not obtained by chance factors or sampling errors.

4.3. Main and Interaction effects of the Independent Variables on SPM Test Scores

Different levels of Factorial designs were applied to look into the analyses of variance; and observed F-ratios were tested for significance.

4.3.1. Type of Schooling, SES and SPM Test Scores

A two-way analysis of variance was computed to examine the effect of type of Schooling (row effect), SES (column effect) and their interaction effect (row x column) on SPM Test Scores. Summary of the analysis is given in Table - 6. Highly significant mean differences were obtained between the types of schooling and between SES groups even at .001 level of significance ($_{.999}F_{1,596} = 11.00$). There is large difference between the observed F-ratios and the critical F-ratios for both variables. Therefore chance factors or sampling errors did not attribute to the differences obtained. The F-ratio observed for the interaction effect was below one and thus represented by the error mean square. This signifies that there is little or no interaction effect by the independent variables upon SPM Test Score.

Proportions of variance in the dependent variable

Table - 6

Two-way Summary ANOVA. SPM Test Scores by Type of Schooling and SES.

Source of Variation	Sum of squares	Degrees of freedom	Mean Square	F
Between Type of Schooling and SES				
Between Type of Schooling	9252.33	1	9252.33	59.77***
Between SES	4169.60	1	4169.60	26.94***
Within Type of Schooling and SES	92252.04	596	154.79	
Total	105673.97	598		

***Significant < .001

accounted for by each independent variable (with respect to rows, columns and interaction cells) was computed by using the following formula (Hays, 1981).

$$R^2_{Y.A} = \frac{\text{Sum of square rows}}{\text{Total sum of squares}}$$

$$R^2_{Y.B} = \frac{\text{Sum of square columns}}{\text{Total sum of squares}}$$

$$R^2_{Y.AB} = \frac{\text{Sum of squares interaction}}{\text{Total sum of squares}}$$

Therefore, the proportion of variance accounted for by the row factor (Type of schooling) is .088, by the column factor (SES), is .04, but only .001 by interaction.

4.3.2. Type of Schooling, Grade level and SPM Test Scores

A two-by-three analysis of variance was made to examine the main effects of type of schooling (row) and grade level (column); and their interaction effect (Type of Schooling x Grade level) on SPM Test Scores. Summary of the analysis is presented in Table - 7. Highly significant F-ratios were observed in the main effects even at .001 level of significance ($_{.999}F_{1,593} = 11.00$ and $_{.999}F_{2,593} = 7.00$ respectively). Therefore, there are large mean differences between type of schooling and between grade levels.

The observed F-ratio for interaction is significant below .01 level of significance ($_{.99}F_{2,593} = 4.65$) indicating that the joint effect of type of schooling (rows) and grade level (columns) on SPM Test scores signifies the relationship between performance on SPM Test and the combination of the independent variables. Their interaction is better explained in Figure - 2. The lines connecting the cell means are not parallel to each other and thus, a significant interaction between the variables is observable. The cell means for Non-Government school subjects are larger across all the three grade levels as observed in the ordinal interaction. The lines are much departed showing differences in the mean scores of grade 7. The differences come closer as grade level increases. It might be the

Table - 7

Two-by-Three Summary ANOVA. SPM Test Scores by Type of Schooling and Grade level

Source of Variation	Sum of Squares	Degrees of freedom	Mean Square	F
Between Type of Schooling and Grade level				
Between Type of Schooling	9252.33	1	9252.33	59.74***
Between Grade level	2701.33	2	1350.67	8.72***
Interaction (Type of Schooling x Grade level)	1881.82	2	940.91	6.10**
Within Type of Schooling and Grade level	91838.49	593	154.87	
Total	105673.97	598		

*** Significant < .001

** Significant < .01

nature of the test that which brings an increase in the level of difficulty of items as grade level decreases. In addition, the ability to perceive and identify relationship might be affected by various environmental factors.

With respect to the proportion of variance in the SPM Test Scores, type of schooling contributed. .088, grade level contributed .026, and the variance accounted for by the interaction is .02. The proportions imply that the

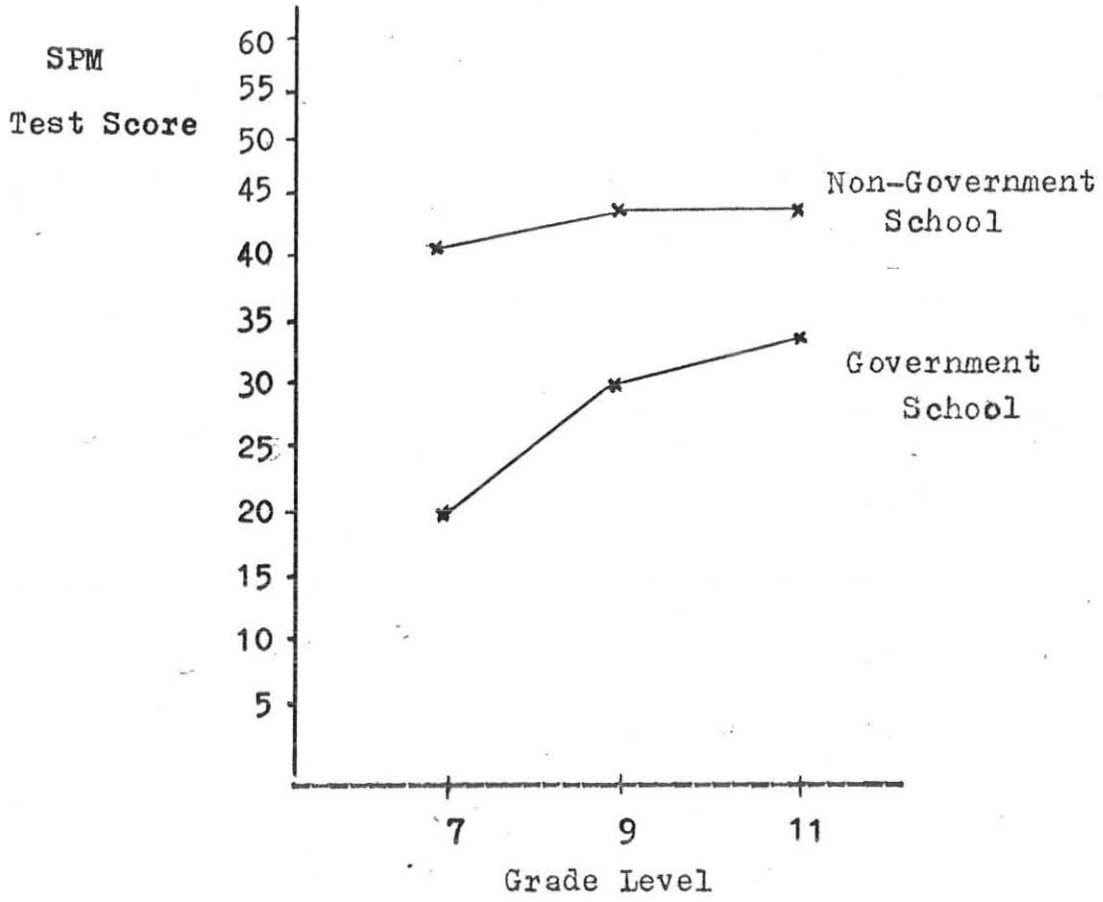


Figure-2. Plot of interaction between type of schooling and grade level.

variance explained by each variable is small though main and interaction effects revealed significant mean differences.

Pair-wise mean comparisons were employed to decide which pairs of means are equal for Grade levls (Appendix-6-2).

Table - 8 presents the obtained F-ratios. The table indicates that mean differences between Grade 7 and the other grade levels are statistically significant at .05 level ($_{.95}F_{2,593} = 6.62$), but there is no statistically significant mean difference between Grades 9 and 11. The same result was obtained in section 4.2.

Table - 8

Paire-wise mean comparisons between Grade 7, 9 and 11

Groups	F
Grade 7 and 9	11.378*
Grade 7 and 11	17.08*
Grade 9 and 11	1.658

*Significant < .05 ($F_{cv\ (.05)}$ = 6.02 for df = 2,593)

4.3.3. Type of schooling, Sex and SPM Test Scores

The two-way analysis of variance indicated (see Table - 9) that there is a highly significant mean difference between type of schooling (row effect) even at .001 level of significance ($_{.999}F_{1,596}$ = 1.00). Sex (column effect) was not found significant at .05 level of significance ($_{.95}F_{1,596}$ = 3.86) indicating that there is no relationship between sex and SPM Test Scores. The interaction effect of type of Schooling and sex upon SPM Test revealed an F-ratio below 1, but added to the error and indicated that there is apparently little or no joint effect. The proportion of variance accounted for by type of schooling is .088, and by sex is .0058.

Table - 9

Two-way Summary ANOVA. SPM Test Score by Type of Schooling and Sex

Source of Variation	Sum of Squares	Degrees of freedom	Mean Square	F
Between Type of Schooling and sex.				
Between Type of Schooling	9252.33	1	9252.33	57.56***
Between Sex	611.11	1	611.11	3.80
Within Type of Schooling and Sex	95810.53	596	160.76	
Total	105673.97	598		

***Significant < .001

4.3.4. SES, Grade level and SPM Test Scores

A two-by-three analysis of variance presented in Table - 10 showed that SES (row) is highly significant even at .001 level of significance ($_{.999}F_{1,596} = 11.00$) implying that SES groups have statistically meaningful mean differences. Grade levels were also found to be significant at .001 level of significance ($_{.99}F_{2,593} = 7.00$). Previous inspections of the means in both variables (SES and Grade level) revealed similar results.

The observed F-ratio for the joint effect of the variables was found not significant even at .10 level of significance ($_{.90}F_{2,593} = 2.31$) indicating that there is no relationship between membership of subjects in either of the independent variables and SPM Test scores. In addition, the proportion of variance accounted for by SES is .04, by Grade level .03 and by their interaction is only .006. Though the proportions are small, they significantly affect the dependent variable (SPM Test) within their respective groups.

Table-10

Two-by-Three Summary ANOVA.SPM Test Scores by SES and Grade level

Source of Variation	Sum of Squares	Degrees of freedom	Mean Square	F
Between SES and Grade level.				
Between SES	4169.60	1	4169.60	25.17***
Between Grade level	2701.33	2	1350.67	8.15***
Interaction (SES X Grade level)	585.31	2	292.66	1.77
With SES and Grade level	98217.73	593	165.63	
Total	105673.97	598		

***Significant < .001

Pair-wise mean comparisons were employed in testing which pair of grade levels were significantly different (Appendix - 6.3). The obtained F-ratios are shown in Table - 11. Mean differences between grade 7 and the remaining grade levels are highly significant at .05 level ($_{.95}F_{2,593} = 6.02$). There is no statistically significant difference between the mean scores of grade 9 and 11. The same result was obtained in sections 4.2 & 4.3.2.

Table - 11

Pair-wise mean comparisons between Grade 7, 9 and 11

Groups	F
Grade 7 and 9	10.64*
Grade 7 and 11	15.972*
Grade 9 and 11	1.55

*Significant < .05 ($F_{cv(0.05)} = 6.02$ for df = 2,593)

4.3.5. SES, Sex and SPM Test Scores

The analysis of variance of SPM Test Scores interms of the independent variables SES and Sex (see Table - 12) revealed that SES (rows) has significant differences between its groups (upper and lower class) since the observed F-ratio exceeded the tabled value of F even at .001 level

of significance ($_{.999}F_{1,596} = 11.00$). But there is no significant difference between the sex groups at .05 level of significance ($_{.95}F_{1,596} = 3.86$). Since there is little or no joint effect of SES and sex, all of the residual variation represents the interaction effect.

The proportion of variance accounted for by SES is .04 and it is only .006 that is accounted for by sex. The contributed proportions are similar as indicated in the analyses made before.

Table - 12

Two-Way Summary ANOVA.APM Test Scores by SES and Sex

Source of Variation	Sum of Sequares	Degrees of freedom	Mean Square	F
Between SES and Sex				
Between SES	4169.60	1	4169.60	24.63***
Between Sex	611.11	1	611.11	3.61
Within SES and Sex	100893.26	596	169.28	
Total	105673.97	598		

***Significant < .001

4.3.6. Grade level, Sex and SPM Test Scores

As the summary of the analysis of variance indicates (see Table-13), the grade levels (rows) showed statistically significant mean difference at .001 level of significance

($_{.999}F_{2,596}$ = 7.00). The same result was obtained in mean inspections of the grade levels in the preeceding sections. The sex groups (columns) have statistically nonsignificant mean differences between them at .05 level of significance ($_{.95}F_{1,596}$ = 3.86). This result was also obtained in previous examinations of the variable (Sex) on SPM Test Scores. All of the within-class variation represents the interaction effect because of the fact that the interaction of Grade level and sex has apparently little or no effect on SPM Test. In addition the proportions of variance accounted for by Grade level and sex are .03 and .006.

Table - 13

Two-by-Three Summary ANOVA.SPM Test Scores by Grade level and Sex

Source of Variation	Sum of Squares	Degrees of freedom	Mean Square	F
Between Grade level and Sex.				
Between Grade level	2701.33	2	1350.67	7.85***
Between Sex	611.11	1	611.11	3.55
Within Grade level and Sex	102361.53	595	172.04	
Total	105673.97	598		

***Significant < .001

Pair-wise mean comparisons for the grade levels (Appendix-6-4) showed that the mean differences between grade 7 and the other grade levels are highly significant at .05 level of significance ($_{.95}F_{2,595} = 6.02$) as obtained in sections 4.2, 4.3.2 and 4.3.4. There is no statistically proved mean difference between grades 9 and 11. The F-ratios obtained for the grade levels are given below (Table - 14).

Table - 14

Pair-wise Mean Comparisons Between Grade 7, 9 and 11

Groups	F
Grade 7 and 9	10.24*
Grade 9 and 11	15.38*
Grade 9 and 11	1.493

*Significant $<$ .05 ($F_{cv(.05)} = 6.02$ for df =2,595)

4.3.7. Independent and Overall effects of the treatment variables on SPM Test Scores

The summary of all possible combinations is presented in Table - 15. The three main effects, type of Schooling, SES and Grade level were found significant even at .001 level of significance ($_{.999}F_{1,575} = 11.00$; $_{.999}F_{2,575} = 7.00$).

Table - 15

Summery of 2 x 2 x 3 x 2 ANOVA. SPM Test Scores by Type of Schooling, SES, Grade levels and Sex

Source of Variation	Sum of Squares	Degrees of freedom	Mean Square	F
Between Cells				
Type of Schooling	9252.33	1	9252.33	63.29***
SES	4169.60	1	4169.60	28.52***
Grade level	2701.33	2	1350.67	9.24***
Sex	611.11	1	611.11	4.18
Interactions				
Type of Schooling X SES	105.84	1	105.84	.72
Type of Schooling X Grade level	1881.82	2	940.91	6.44**
Type of Schooling X Sex	4.56	1	4.56	.03
SES X Grade level	292.66	2	146.33	1.00
SES X Sex	4.34	1	4.34	.03
Grade level X Sex Type of Schooling X	133.48	2	66.74	.46
SES X Grade level Type of Schooling X	912.41	2	456.21	3.12
SES X Sex	131.73	1	131.73	.09
Type of Schooling X Grade level x Sex	990.47	2	495.24	3.39
SES X Grade level X Sex	76.21	2	38.11	.26
Type of Schooling X SES X Grade level X Sex	353.80	2	176.9	1.21
Within Cells	84052.28	575	146.18	
Total	105673.97	598		

***Significant < 001

**Significant .01

Sex was significant at .05 level of significance ($.95F_{1,575}$= 3.86). The differences among the obtained mean scores of SPM Test, therefore, are not affected by chance factors or sampling fluctuations. Unlike to previous findings sex revealed significant mean differences which might be the result of the distribution of error among the other independent variables. In addition, there is difference in the degrees of freedom which affect the mean square error. Further, the difference between the observed t obtained for sex in section 4.2 and the square root of the observed F obtained here reflect the difference in the degrees of freedom employed (t obtained = 1.86 with 597 df, and F = 2.04 with 575 df).

In the table, two-and thrge-level interactions are presented so as to examine all possible combinations and to represent in a summary the four -factorial design showing the joint effect of the treatment variables upon SPM Test. Among the two level interactions, it was only the interaction between type of schooling and grade level that has shown statistically significant difference in the mean scores of SPM Test at .01 level of significance ($.99F_{2,575}$ = 4.65). The remaining interaction effects in the two level are non singificant at .05 level of significance. In tests of significance of the obtained F-ratios in the three level, the interactions between type of schooling, SES and grade level; and the interaction between type of Schooling

Grade level and sex were found significant at .05 level of significance ($_{.95}F_{2,575} = 3.01$). All the remaining interactions including the interaction of all treatment variables indicated non significant mean differences.

Regarding the proportions of variance, each factor contributed as equal proportions as indicated in the preceeding sections. In general the interactions contributed a very small amount to the total variance ranging from .00004 to .018 implying that except the interaction between types of schooling and grade level all interactions did not affect SPM Test. Pair-wise comparison among the three grade levels (7, 9 and 11) pointed out significant mean differences as mentioned before (section 4.3.2 and 4.3.6).

In summary, the main and interaction effects of the four independent variables were examined. Type of schooling, SES and Grade level were found to be highly significant while sex was found nonsignificant consistently in all the analyses made except in the last analysis which considered all possible combinations of the independent variables. Interactions also were non significant except for the interaction between Type of Schooling and Grade level. The proportions of variance that each contributed to the total variance are all very low and significant amounts of residual were observed in all the analyses conducted.

Therefore other unexplained sources of variations have affected the SPM Test.

4.4. Relationships between the independent variables and the SPM Test.

Product-moment correlations were computed to examine relationships between each independent variable and the criterion variable. The coefficients of correlations obtained are presented in Table - 16. As the coefficients indicate SPM Test is related with the independent variables in small magnitudes (below .30). Test of the significance of the correlation coefficients was done using t-tests (Hinkle, Wiersma & Juris, 1979), i.e.

$$t = r\sqrt{\frac{n-2}{1-r^2}}$$

Where r = the observed correlation coefficient

n = sample size

The test yielded significant correlation coefficients between SPM Test and the variable Type of Schooling and SES at .001 level of significance ($t \pm 3.291$, df = 597). Grade level correlated with SPM Test at .01 level of significance ($t \pm 2.576$, df = 597). Sex was not found significant at .05 level of significance ($t \pm 1.960$ df = 597). The over all relationship of the independent variables with SPM Test was caluclated to be .3538 (multiple R) which showed that there is low positive association between SPM Test and

Table - 16

Product-Moment Correlations be$ween SPM Test and Type of Schooling, SES, Grade level and Sex (N = 599)

Variables	r	t
Type of Schooling	.2959	7.5688***
SES	.2497	6.3006***
Grade level	.1193	2.9359**
Sex	.0761	1.8648

*** Significant .001

** Significant .01

the linear combination of the independent variables. Further, about 13 per cent of the variation (multiple R^2) in the criterion is accounted for by the linear combination of the variables. Test of the significance of the obtained R was computed using the following F Statistic (Hinkle, Wierama & Juris, 1979).

$$F = \frac{R^2/k}{(1-R^2)/(n-k-1)}$$

Where k = number of independent variables

R = multiple correlation coefficient

n = sample size

Thus, the observed F - ratio was 21.2481 which exceeded the tabled value of F ($_{.999}F_{1,594} = 11.00$). Therefore, it can be concluded that there is a non-zero relationship between the criterion varialbe and the linear combination of the treatment variables.

With respect to the controlled contribution of the independent variables to the variation established in the dependent variable, partial-correlation coefficients were computed. Table - 17 presents the correlation coefficients computed.

Table - 17

Partial-correlation coefficients between SPM Test Scores and Type of Schooling, SES, Grade level and sex

(N = 599)

Variables	r	t
Type of Schooling	.2337	5.857***
SES	.1734	4.2905***
Grade level	.1051	2.5757**
Sex	.0734	1.7938

***Significant .001

**Significant .01

The magnitude of the correlation coefficients is obviously very low but positive. Test of the significance of each partial correlation was done using the following statistic (Glass and Hopkins, 1984).

$$t = \frac{r_{yx_1 \cdot x_2 \cdot x_3 \cdots x_p} \sqrt{N-2-v}}{\sqrt{1 - r^2_{yx_1 \cdot x_2 \cdot x_3 \cdot x_p}}}$$

Where $r_{yx_1 \cdot x_2 \cdot x_3 \cdot x_4}$ = partial correlation coefficient of x_1

N = sample size

v = number of independent variables partialled out

Partialling out the influence of the other independent variables, types of Schooling has significantly correlated with SPM Test even at .001 level of significance ($t \pm 3.291$, df = 593). The proportion of variance that it contributed to the total variance is about 5.5 percent ($R^2_{yx_1 \cdot x_2 x_3 x_4}$ = .05461) which is larger than the contribution of the other treatment variables. The partial correlation coefficient of SES with SPM Test also indicated a nonzero significant relationship at .001 level of significance ($t \pm 3.291$, df = 593), and 3 per cent of the total variation is accounted for by SES ($R^2_{yx_2 \cdot x_1 x_3 x_4}$ = .03) partialling out the effect of the remaining three treatment variables, Grade level showed that it is significantly related with SPM Test at .01 level

of significance ($t \pm$ 2.576, df = 593). The proportion of variance contributed to the total variation by Grade level is about 1 percent ($R^2_{yx_3 \cdot x_1 x_2 x_4} = .011046$). A nonsignificant partial correlation coefficient was obtained for sex with SPM Test at .05 level of significance ($t \pm 1.96$, df 593). Sex contributed insignificantly to the total variation of SPM Test Scores ($R^2_{yx_4 \cdot x_1 x_2 x_3} = .0054$).

In summary, very low correlations were obtained when overall and independent correlation coefficients were examined. Tests of significance, however, revealed that type of Schooling, SES and grade level are significantly related with SPM Test, while apparently little relationship was exhibted between sex and SPM Test.

CHAPTER FIVE

DISCUSSION

The purpose of this study was to investigate the 'culture-fairness' of SPM Test on subjects from different social, educational and demographic backgrounds. Within this general aim the investigation focused on examining whether or not mental ability scores, measured using SPM Test (1958) are affected by cultural experiences of individuals.

The SPM Test which assumes to signify genetic individual differences rather than culturally induced differences, is usually examined before applications for its 'culture-fairness'. Cross-cultural investigations therefore, attempt to examine the test with respect to the above understanding. Similar attempt has been made in the present study.

In this chapter discussion of the results will be presented. In the last part of the discussion some general observations will also be made.

5.1. Overall effect of the independent variables on SPM Test

As indicated in the preceeding section, the analysis revealed that the SPM Test yielded significantly different scores for the sample when grouped under the two types of schooling (Government, Non-Government), the two SES groups

(upper and lower), the three grade levels (Grades 7, 9 and 11). Higher mean scores were obtained by the Non-Government Schools' Subjects and higher SES subjects. Mean scores also increased as grade level increased. In addition to that, the test indicated nonsignificant difference between the sex groups in all cross-comparisons. Grade level was observed to interact with the other variables (except sex) which implies that grade level was important in distinguishing performance in type of schooling and SES groups.

Type of schooling was a strong variable in the test alone and in all Gross-comparisons. Difference in SES was also found to be influential (similar findings were reported in Tulkin and Newbrough (1968), Elley and MacArthur (cited in Tulkin and Newbrough, 1968) and Townsend (1982)).

In general the analysis of variance showed that the test has differentiated individuals when grouped under different factors except in sex. However, the magnitude of relationship was found low as indicated by the proportion of variance accounted for by each independent variable to the total variance. The remaining unexplained larger part of the variance seems to be attributed to other external factors which are not controlled.

5.2. Type of Schooling

As shown earlier, the SPM Test scores differ in the two types of schooling significantly. This is taken to

mean that difference between the subgroups exist and the difference is dependent upon type of schooling. Even-though the variation due to type of schooling accounted in the total variance is small, the amount signifies the dependency between SPM Test and type of schooling in comparison with the contribution of the remaining variables.

In the interaction analysis, type of schooling showed significant joint effect on the test only with grade level. SES was expected to be significant on the scores when combined with type of schooling because stratifications were made to reflect SES. However, the interaction was almost nonexistent as indicated in Table - 6. An important implication from the absence of interaction is that, enrollment of subjects in a type of schooling influences more than mere membership in a definite SES group.

The interaction between type of schooling and grade level was rather significant (see Table - 7). The indication from this observation is that enrollment in a type of schooling and membership in higher or lower grade level affects SPM TEST. Further, the result indicated in all grade levels, subjects who are in Non-Government schools perform better than those who are in Government schools. Similar indication is seen from the plot of interaction between type of schooling and grade level (see figure - 2). The difference is wide for grade 7 subjects and comes relatively closer for grade 11 subjects. It seems in general that conditions in the two types of schools get similarity as grade level increases.

The only variable that could not produce joint effect is sex (see Table - 9). The analysis showed no indication about the relationship between membership in a sex group and learning in a type of schooling. This may partly be attributed to the similar environmental experiences that the sexes obtain in their respective type of schools. Convergence of their patterns of abilities in figure-analogy through education and reproduction may be another probable source for the nonsignificant relationship observed between SPM Test and Sex. Added to that, the effect of similarity in developmental stage of both sexes found in (Formal-operations) could be taken as a source for the nonsignificant relationship.

The results of the present study support findings by Klingelhofer (1967) who found significantly better performance at all educational levels on SPM Test (1960) by Asian groups whose environmental conditions in schools are better than those of African schools in Tanzania. Explaining how homogeneity in type of schooling affects performance on tests, Irvine (cited in Klingelhofer, 1967) notes that, ...

> As societies develop, school systems become more homogeneous. Consequently, the effect of school quality on test performance will decrease in direct proportion to the increase in standards of teaching and school amenities.

Irvine's assertion reflects that the difference between the two types of schooling considered in turn affect SPM Test.

The conditions of the two types of schools under this study are in general different in standard of teaching and in school amentities. Where as environment in government schools is characterized by scarce educational facilities and less academic control on students, the situation in Non-Government schools is relatively conducive for educational activities. If it can be argued that education has positive effect on performance, it can be said the Non-Government school environment is relatively a favourable one. Therefore it may be this marked difference that affected the SPM Test.

Factors related to examiner's language, time limitations, bias in items, verbal ability and the effect of practice seem to have contributed very little to the marked differences. The fact that the use of language was controlled (as indicated by Vernon, 1967) has minimized the possible difficulty that can be caused by language even in instruction.

SPM Test is a measure of general mental ability with items having patterns which should be first perceived totally and then need clear thinking in order to identify relationships between the selected fit and the gap interms of figure-background relationship (Raven, 1961). In this respect, the patterns of responses revealed the patterns of abilities in that in both groups subjects were found to increase in incorrect number of responses from part A to E. However for the subjects in the Non-Government schools, the pattern was a bit different. Their incorrect responses were observed

dominantly in parts D and E. This has direct relationship with the arrangement of the items in order of increasing difficulty. There is of course no research indication concerning patterns of abilities of Ethiopian individuals.

5.3. SES

SES represents sub-cultural experiences gathered by individuals (Rodman, 1968), and there is relationship between SES, values, orientations and behavior which is consistent and meaningful (Kohn, 1977 cited in Habtamu, 1989). Different subcultures provide different experiences formally and informally. SES control the type, magnitude and system of provision of experiences. In fact an individual's vicinity is not the only source of such experiences. The gathered experiences separate groups of individuals in terms of class culture. The separation by and large is reflected in performance on tests.

The SPM Test is assumed to reflect the above mentioned features in the performance of subjects from the upper and lower SES groups considered. Thorndike (1968) suggests to give emphasis to the identification of specific factors that produce differences on tests. However in this study gross influence of father's or guardian's occupation and education level was considered.

As indicated in the result, SES has significantly influenced SPM Test. There are no additional findings to

clarify the extent of influence of each gross factor. Regarding the effect of the factors on SPM Test, Similar results were reported in Tulkin and Newbrough (1968) and Hŏndel (1973). However further investigation is needed to point out which factor (occupation) or education level is more related to SPM Test.

Results of the study further seem to suggest that lower SES subjects obtained significantly lower scores (see Table - 3), which support similar finding in Tulkin and Newbrough (1968). As the proportion of variance accounted for by SES is minimum, it can be said that the variable has lesser magnitude of relationship with SPM Test. These findings are in conformity with Handel (1973), Townswend (1982) and Bart (1986).

With regard to the interaction effects, SES appeared to be related with grade level only. The interaction between grade level and SES has significant effect on the performance of subjects. Membership in a grade level and in a SES group is related with SPM Test. In addition, their interaction may also reflect the effect of SES on academic achievement which needs further investigation in Ethiopian Social conditions.

5.4. Grade level

Educational experience is most marked in relation to SPM Test(Mclaurin and Farrar, 1973); as educational experience develop, its influence is directly related to

the development of mental ability specially in the ages of rapid mental development. And, the fact that the magnitude of influence is not with the same degree to all individuals work in all age levels (Powers and others, 1986).

In the present study, grade level has affected SPM Test scores significantly. Significant differences in the mean scores have been obtained. Thus, as grade level increased mean scores also increased. However, the total influence seems weak in magnitude. Several findings report similar weak but highly significant magnitudes (Tulkin and Newbrough, 1968; Wober, 1969; Purl and Curtis, 1970; Baraheni, 1974; Brown, 1983; Powers and others, 1986).

In the Non-Government schools in which relatively better educational amenities are available, relationship between grade level and SPM Test is more significant. As the level of education and SES go lower the relationship however becomes less marked. Explaining his view against homogeneity of schools and the effect of education, Thorndike (1968) pointed out that in an environment where the whole range of intellectual activity is assumed, the relationship between educational experience and mental ability tests becomes less marked as the level of education goes higher and to homogeneous groups. Findings reported in Keehn and Prothro (1955), Klingelhofer (1967); MacArthur and others (1964), too, support Thorndike's view. In addition to the explanation given by Thorndike, these researchers emphasized how the nature of SPM Test and environmental influences

affect performance of subjects from such school conditions.

The fact that the subjects belong to different socio-cultural background might have affected the test. School environment, the amount of time spent in schools, the ability to percieve and to identify relationships might as well have had a similar effect.

Jensen (1972) is against the cultural effect of educational experience on SPM Test. He argues that it is not reliable to conclude that education has a considerable part to play in the performance of subjects on SPM Test. For him it is when through analysis of item difficulty, item intercorrelations and factor structure of the test that evidences become more reliable. His argument is in general to control confounding elements. However in the present study grade level was controlled by type of schooling and SES unless its effect is confounded by other uncontrolled factors.

5.5. Sex

Many investigators hypothesized that sex differences on SPM Test are genetic and the differences would be in accordance with a nuber of observed physical sex differences (Kamin, 1978). This assertion is, in fact against the view of Thorndike (1968) which considers sex differences as elements which cannot be avoided with regard to any type of test and considerably reflect cultural effects rather than genetic effects.

This study, as mentioned earlier, showed nonsignificant effect of sex on SPM Test. Several investigations, (Kamin, 1978; Jensen, cited in Kamin, 1978; Powers and others, 1986), have also reported similar results. This result is obtained may be partly because of the similarity in environmental epxeriences that both sexes are gathering or it may be partly due to the test's nature that its items affect the sexes in equal terms. Obviously, Thorndike's assertion on sex differences in all types of tests is against what is obtained in this study. The findings of Baraheni (1974) also indicate similar assertions with Thorndike.

The strength of sex could not be increased by adding interactions and remained independent from the other variables. Further patterns of responses were similar in both sex groups. Both were found to increase in the number of incorrect responses in part C to E.

5.6. Relationships between SPM Test and the treatment variables

The fundamental claim of SPM Test, i.e. cultural and environmental experiences do not influence scores on SPM Test, was also investigated through correlational analysis. Thus, product-moment correlation coefficients have given results in the present study.

As the results indicated, SPM Test is found to correlate significantly with type of schooling, SES, and grade level, but not with sex. However the magnitude of the coefficients is very small. The results obtained lend support to the reports of Keehn & Prothro (1955), Tulkin & Newbrough (1968), Wober (1969), Jensen (1969), Cronbach (1970), Mclaurin & Farrar (1973) and powers and others (1986).

The obtained correlation coefficients signify that SPM Test is positively related with all the variables. This implies that changes in representation and scores of the variables result in direct change in SPM Test Scores. The obtained correlation coefficients would not be non-zero if the SPM Test is reflecting what it claims. The correlation coefficient obtained ranged from .0761 to .2959.

The linear combination of all the treatment variables with SPM Test also reveals how with small magnitude of correlation that the test correlates with the treatment variables. The obtained correlation coefficient ($R = .3538$) is however, positive and highly significant even at .001 level of significant.

The partialled out correlation coefficients also point out similar results. The observed relationships are low in magnitude, positive in direction and significant at and below .05 level of significance. The contribution of the treatment variables to the total variation in SPM is very low. Therefore, it can be said that SPM Test has minimized the effect of each treatment variable.

CHAPTER SIX

SUMMARY AND CONCLUSION

The purpose of the present study was to examine closely the fundamental claim of the Raven's Standard Progressive Matrices Test: 'cultural and environmental experiences in general do not affect scores on the test'.

In order to examine the claim, grade seven, nine and eleven subjects (N = 599) were randomly selected from three Government and two Non-Government Schools found in Addis Ababa. It was conjectured that mean scores on SPM Test would not be different if the subjects are grouped under Government and Non-Government schools, upper and lower SES, grade seven, nine and eleven, or under male and female sex groups.

Raven's Standard Progressive Matrices Test (1958) was administered to obtain 'culture-fair' general mental ability scores, and an adapted index of social positions was administered to determine SES or position of subjects.

Factorial designes following t-tests were employed to examine mean differences between the above mentioned groups. Simple, multiple and partial correlation coefficients were computed to consider relationships between the SPM Test and type of schooling, SES, grade level and sex.

The results of the study showed that, Government

and Non-Government school groups, and upper and lower SES groups differ significantly in mean scores of SPM Test. In addition, grade 7 was significantly different from grade 9 and 11 in mean scores of SPM Test. There was no statistically significant mean difference between grade 9 and 11 sujects. The sex groups also showed no statistically significant mean differences. Type of schooling, SES and grade level were consistently significant and sex remained nonsignificant across all cross-comparisons upon the SPM Test Scores. Significant interaction was only obtained between type of schooling and grade level.

The result also pointed out that, the SPM Test is significantly correlated with type of Schooling, SES and grade level but revealed very low and positive magnitudes of relationships in both simple and multiple correlations computed. The total proportion of variance accounted for by the treatment variables is about 13 percent.

The unexplained larger proportion seems to be related probably with other cultural, environmental and genetic factors. Since the study is limited to those few treatment variables, the unexplained proportion of variance cannot be said that it revealed genetic differences only.

Regarding each treatment variable, there seems further need to identify sub-factors which are assumed to influence

general mental ability. In addition, cultural and environmental factors may explain more if related with age and academic achievement.

SPM Test measures the current mental performance irrespective of what a subject obtained in his or her previous experience. This can be done with the use of additional tests which can measure previous experience (For example Number Series Test).

The general conclusions drawn from this study are:

1. The Raven's Standard Progressive Matrices Test (1958) score seems to vary as a result of cultural and environmental influences.

2. Difference in type of schooling has contributed more variance than SES, grade level and sex.

3. SPM Test is positively related with type of schooling, SES, grade level and sex.

In addition, this study also suggests various areas for future investigation. Among this is, repeating the same research on a wider population by including other relevant variables such as child-rearing practices, feeding practices, academic achievement, language ability and methods of teaching. Item-analytical studies may also give hints for further investigation of the patterns of abilities of

Ethiopian subjects in terms of perception, identification and drawing of relationships from the general to the particular (deduction) and from the particular to the general (induction) following the principle of neogenesis.

REFERENCES

Anastasi, Anne (1976) , Psychological Testing, 4th edition, McMillan Publishing Comp. USA.

Baraheni, M.Naghi (1974), Raven's Progressive Matrices as applied to Iranian Children. Educational and Psychological Measurement. 34, 4, 983 - 988.

Bart, W.M.J; Rother, W.J. & Read, s. (1986). An ordering-Analythic Approach to the Study of Group Differences in intelligence. Educational and Psychological Measurement. 46, 4, 799 - 810.

Bertrand, A. & Cebula, J.P. (1980), Tests, Measurement, and Evaluation. A developmental approach. Addison - Wesley Publishing Comp. USA.

Bowers, John E. (1967), Academic Performance and test scores for freshmen at Hailesellassie I University. Addis Ababa. HSIU Faculty of Arts. Mimeographed.

Brown, Frederick (1983). Principles of Educational and Psychological Testing, 3rd edition. Holt, Rinehart and Winston, USA.

Buros, Oscar K. (1953), Mental Measurements Year Book. 4th edition Vol. I.

_____ (1985). Mental Measurements Year Book. 9th edition Vol. II

Central Statistical Authority (1987), Analytical report on the population of Addis Ababa. Addis Ababa, Vol. I, No. I.

Croman, L. & Budoff, M. (1974), Factor structure of retarded and non-retarded children on Raven's Progressive Matrices Test. Educational and Psychological Measurement. 34, 4, 407 - 412.

Cronbach, L.J. (1970), Essentials of Psychological Testing. 4th edition, Harper & Row. New York.

Dandes, H.M. & Dow, D. (1969). Relation of intelligence to family size and density. Child development. 40, 641 -644

Dillon, R.F.J. Pohmann, J.T. & Lonmon, D.F. (1981). A factor analysis of Ravens advanced Progressive Matrices freed of difficulty Factor. Educational and Psychological Measurement. 41, 1295 - 1302

Dockrell, W.B. (1970), On Intelligence. The Toronto Symposium on Intelligence. Methuen & Co. Ltd. London.

Fracchia, J.F.; Fiorentino, D. J. Sheppard, C. & Merills, S. (1969) A comparison of Techniques for the scoring of avodidable errors on the Raven Progressive Matrices. Journal of Psychology. 72, 93 - 98.

Glass, Gene V. and Hopkins, Kenneth D. (1984). Statistical Methods in Education and Psychology. 2nd edition Prentice hall, INC. USA.

Guilford, J.P. (1967). The Nature of Human Intelligence. McGraw - Hill Book Com. USA.

Habtamu Wondimu (1989), Gratification Patterns among Peasants and workers in Central Ethiopia. The Ethiopian Journal of Education. Institute of Educational Research. Addis Ababa University. Vol. 2, no. 1

Hondel, Amos (1973), Cognitive Styles among Adolescents in Israel. International Journal of Psychology. 8, 4, 255-67

Hays, William Lee (1981), Statistics. 3rd edition, Holt, Rinehart and Winston.

Hinkle, E. Dennis; Wiersma, William & Turis, S.G. (1979). Applied Statistics for the Behavioral Sciences. Houghton Houghton Mifflin Co. USA.

Hopkins, K. & Stanley, J.C. (1981). Educational and Psychological Measurement and Evaluation. 6th edition, Printice - Hall, INC. USA.

Jensen, Arthur R. (1969). How much can we boost IQ and scholastic achievement. Harvard Educational Review. 39,1-123

_____ (1972). Improving the assessment of Intelligence. Paper presented in symposium, " The Theory of Intelligence." WPA. Portland, Ore.

_____ (1980) Bias in Mental Testing. Methuen, USA.

Jensen, Arthur R.; Saccuzo, D.P. and Larson, G.E. (1988). Equating the standard and advanced forms of the Raven Progressive Matrices. Educational and Psychological Measurement. 48, 4, 1091 - 1095.

Jones, Harold E.(1954). The Environment and Mental development. In L. Carmichael (Ed.) Manual of Child Psychology. John Wiley & Sons. Inc. USA. pp. 631 - 696.

Kamin, L. (1978), Sex differences in susceptibility of IQ to Environmental influence. Child Development. 49, 517 - 518.

Keating, Daniel P. (1978), A search for social Intelligence Journal of Educational Psychology, 70, 2, 218 - 223.

Keehn, J.D. & Prothro, E. Terry (1955), Non-Verbal Tests as Predictors of Academic Sucess in Lebanon. Educational Psychological Measurement. 15: 495 - 498.

Kellingelhofer, E.L. (1967), Performance of Tanzanian Secondary School Pupils on the Raven Standard Progressive Matrices Test. The Journal of Psychology. 72, 205 - 215.

Kolesnik, Walter B. (1963). Educational Psychology. McGraw - Hill Book Com.

Lakew Wolde Tekle (1974). Adoption & development of Educational and Psychological Tests. HSIU. Faculty of Education. Mimeographed.

Langmuir, Charles R. (1966-67). Educational and Psychological Tests. HSIU. Faculty of Education. Mimeographed.

Little, William M. (1960). The Wechsler Intelligence Scale for Children: Review of a decade of research. Psychological Bulletin. 57, 2, 132 - 162.

Loevinger, J.L. (1943). On the proportional Contribution of differences in nature & nurture to differences in mental ability. Psychological Bulletin. 40, 125 - 136

MacArthur, R.S., Irvine, S.H. & Brimble, A.R. (1964). The Northern Rhodesia Mental ability survey. Rhodes Livingstone Institute. Lusaka.

McLaurin, W.A. & Farrar, W.E. (1973). Validities of the Progressive Matrices Tests against IQ and GPA. Psychological Reports. 32, 3. Part I. 803 - 806

Meherens, W.A. and Lehmann. I.J. (1984). Measurement and Evaluation in Education and Psychology. 3rd edition. Holt, Rinehart & Winston. USA.

Nitko, Anthony J. (1983). Educational Tests and Measurement: An introduction. Harcourt Brace Jovonvich, INC. USA.

Piaget, J (1964). The Psychology of Intelligence. Ronteledge and Kegon Paul Ltd. London.

Powers, S.J. Patricia, B.J.J and Barkan, J.H. (1986) Validity of the Standard Progressive Matrices as a Predictor of achievement of Sixth - and Seventh - grade students. Educational and Psychological Measurement. 46, 3, 719 - 722.

Purl, M.C. and Curtis, J. (1970) Ravens Progressive Matrices Test Correlations with Measures of large - Thomdike and and Wechster Intelligence Tests. California State Department of Education. Sacramento.

Raven, J.C. (1961). Guide to Standard Progressive Matrices, sets A,B,C,D,&E. London. H.K. Lewis & Co. Ltd.

Rimoldi, K.J.A. (1948). Study of some factors related to Intelligence. Psychometrika 13, 1, 27 - 46.

Rodman, Heyman (1968). Class culture. American Sociological Review. 31: 673 - 683.

Schnell, Richard R. & Dwarshuis, L. (1967). Progressive Matrices Score & Time. Educational & Psychological Measurement. 27, 485 - 487.

Skemp, Richard R. (1979) Intelligence, Learning and Action. John Wiley & Sons. UK

Sprott, Richard L. (Ed.).(1980.). Age, Learning Ability and Intelligence. Littern Educational Publishing, INC. USA.

Sternberg, Robert J. & Detterman, Douglas K. (Eds.) (1981) Human Intelligence: Perspectives on its theory & Measurement Ablex Publishing Corporation. USA.

Thomdike, R.L. (1968). Intelligence and Intelligence Testing. American Psychologist 23, 811 - 819.

Thomdike, R.L. & Hagen, E.P. (1977). Measurement and Evaluation in Psychology and Education. 4th edition. New York: Wiley.

Townsend, M.A.R.(1982). Measurement of Level I and Level II mental abilities as a function of test and socioeconomic status. Psychological Reports. 51, 135 - 141

Tudenham, R.D. (1970). A 'Piagetian' test of Cognitive development. In W.B. Dockrell (ed.) On Intelligence. London Methuen.

Tulkin, S.R. & Newbrough, J.R. (1968). Social class, race and sex difference on the Raven (1956) standard Progressive Matrices. Journal of Consulting & Clinical Psychology. 32, 400 - 406.

Vernon, Philipe. (1965). Ability Factors and Environmental Influences. American Psychologist. 20, 723 - 733.

_____(1967a). Administration of group intelligence tests to East African Pupils. British Journal of Educational Psychology. 37, 282 - 291.

_____(1970) Intelligence In W.B. Dockrell (Ed.) On Intelligence. London, methuen.

_____(1979). Intelligence.Testing and the nature - nurture debate. 1928 - 1978: What next ? The British Journal of Educational Psychology. 49. Part I. 1 - 14.

Vincent, Ken R. & Cox, John A. (1974) A re-evaluation of Raven's SPM. Journal of Psychology. 88, 2, 299 - 303.

Westby , George (1953). Review on Raven's Standard Progressive Matrices Test. In O.K. Buros Mental Measurements year Book. 4th edition Vol. I.

Wiersma, W. & Juris S.G. (1985) Educational Measurement and Testing. Boston Allyn and Bacon. Inc. USA.

Yates, Aubrey J. (1961). Item analysis of PM (1947). British Journal of Educational Psychology. 31, 2, 148 - 151.

APPENDICES

Appendix - 1

Split-half Reliability Estimation of
Raven's Standard Progressive Matrices Test

Code of Subjects	Total	Score on even items (Y_2)	Score on Odd items (Y_2)	Y_1^2	Y_2^2	Y_1Y_2
01	43	20	23	400	529	460
02	44	22	22	984	484	484
03	46	19	27	361	729	513
04	47	22	25	484	625	550
05	36	16	20	256	400	320
06	23	10	13	100	169	130
07	13	5	8	25	64	40
08	30	14	16	196	256	224
09	27	13	14	169	196	182
10	8	4	4	16	16	16
11	18	8	10	64	100	80
12	22	10	12	100	144	120
13	11	5	6	25	36	30
14	24	10	14	100	196	140
15	36	17	19	289	361	323
16	9	4	5	16	25	20
17	31	14	17	196	289	238
18	8	4	4	16	16	16
19	9	4	5	16	25	20
20	38	16	22	256	484	352
21	50	24	26	576	676	624
22	26	11	15	121	225	165
23	42	20	22	400	484	440
24	52	25	27	625	729	675
25	51	23	28	529	784	644
26	51	25	26	625	676	650
27	39	17	22	289	484	374
28	32	12	20	144	400	240
29	45	21	24	441	576	504
30	12	6	6	36	36	36
Σ	923	421	502	7355	10214	8610

N	30		
M	30.76667	14.033	16.733
SD	14.8456	7.06367	7.90867
SD^2	220.39196	49.8954	62.547

$$r_{y_1y_2} = \frac{N\Sigma y_1y_2 - \Sigma y_1y_2}{\sqrt{N\Sigma y_1^2 - (\Sigma y_1)^2 \; N\Sigma y_2^2 - (\Sigma y_2)^2}}$$

$$= \frac{30(8610) - 421\,(502)}{\sqrt{30(7355) - (421)^2 \;\; 30(10214) - (502)^2}}$$

$$= \frac{258300 - 211342}{\sqrt{(43409)\;(54416)}}$$

$$= \frac{46958}{48601.894}$$

$$r_{y_1y_2} = 0.9661763$$

$$\rho_{y_1y_2} = \frac{2Ry_1y_2}{1+Ry_1y_2}$$

$$= \frac{2(0.9661763)}{1+09661763}$$

$$\rho_{y_1y_2} = 0.9827972$$

Appendix - 2

a) Reliability Estimation of Raven's Standard Progressive Matrices Test Using KR-20

PART	Item	number of Correct responses in the item	P	Q	PQ
A	1	30	1.00	.00	.000
	2	29	.96	.04	.038
	3	30	1.00	.00	.000
	4	29	.96	.04	.038
	5	27	.90	.10	.09
	6	26	.86	.14	.12
	7	18	.60	.40	.24
	8	26	.86	.24	.206
	9	22	.73	.27	.019
	10	18	.60	.40	.29
	11	16	.53	.47	.249
	12	8	.26	.74	.192
B	1	29	.96	.04	.038
	2	28	.93	.07	.065
	3	20	.66	.34	.022
	4	18	.60	.40	.24
	5	14	.46	.50	.014
	6	13	.43	.57	.245
	7	13	.43	.57	.245
	8	12	.40	.60	.24
	9	14	.46	.54	.014
	10	15	.50	.50	.25
	11	15	.50	.50	.25
	12	11	.36	.64	.165
C	1	23	.76	.24	.182
	2	22	.73	.27	.019
	3	23	.76	.24	.182
	4	17	.56	.44	.246
	5	19	.63	.37	.233
	6	15	.50	.50	.25
	7	16	.53	.47	.249
	8	10	.33	.67	.221
	9	16	.53	.47	.249
	10	11	.36	.64	.230
	11	7	.23	.77	.177
	12	0	.00	1.00	.000
D	1	23	.76	.24	.182
	2	24	.80	.20	.16
	3	20	.66	.34	.224
	4	13	.43	.57	.245
	5	19	.63	.37	.233
	6	16	.53	.47	.249
	7	9	.30	.70	.21
	8	18	.60	.40	.24
	9	12	.40	.60	.24
	10	11	.36	.64	.23
	11	5	.16	.84	.134
	12	0	.00	1.00	.000

E	1	18	.60	.40	.24
	2	11	.36	.64	.23
	3	13	.43	.57	.245
	4	9	.30	.70	.21
	5	11	.36	.64	.23
	6	3	.10	.90	.09
	7	9	.03	.97	.029
	8	7	.23	.87	.02
	9	7	.23	.87	.02
	10	2	.06	.94	.056
	11	3	.36	.64	.23
	12	0	.00	1.00	.000
	Σ		30.56		9.405

$$r_{20} \text{ Or } r_{y_1 y_2} \text{ (KR - 20)} = \frac{K}{k-1}\left(1 - \frac{pq}{(SD_x)^2}\right)$$

K = Number of Items

P = Proportion of Passing on Item

Q = Proportion of Failing on Item

$(SD_x)^2$ = Variance of the total score

$$r_{20} = \frac{60}{60-1}\left(1 - \frac{9.405}{220.39196}\right)$$

$$r_{20} = 1.0169492\ (1 - 0.0426739)$$

$$r_{20} = 0.9735519$$

b) Standard error of measurement on the
Raven's Standard Progressive Matrices Test

$$SE = SD_{x_T} \sqrt{1 - r_{yy}^{1}}$$

Where SD_{x_T} = Standard deviation of the total test = 14.8456

r_{yy}^{1} = KR - 20 reliability estimation = .9735519

$$SE = 14.8456 \sqrt{1 - .9735519}$$

$$= 14.8456 \ (.1626287)$$

$$SE = 2.414321$$

Appendix - 3

Development of

INDEX OF SOCIOECONOMIC CHARACTERISTICS

a. Assumptions Considered

1. Every subject is a member of either upper or lower socioeconomic group as defined arbitrarily.
2. A level or status represents generalized characteristics of subjects within itself.
3. It is a subject's parental status that determines his or her socioeconomic position.
4. It is the aggregate weighted score that denotes the status of a subject to be assigned into either upper or lower socioeconomic group.

b. Two indices were used to collect parental socioeconomic positions - Father's or Guardian's occupation and education level. Occupation was given a weight of 5 while education was given 3. Weights determined arbitrarily but reflect relative emphasis.

c. The index is adapted from the Warner-Meeker-Eells Scale (1949) and from Hollingshead's Two Factor index (1957). Categories were taken from these scales but modified according to the classifications used in the analytical report on the population of Addis Ababa published by the Central Statistical Authority (1987).

d. The cutoff score was determined based on the system of classification used in Warner-Meeker-Scale and Hollingshead's Two Factory Index (Hopkins & Stonley, 1981). The maximum obtainable score was 8 and the minimum was 64. The cutoff score was 35. The total score was computed as follows:

$$Isc_{Total} = (5 \times \text{Occupation}) + (3 \times \text{Educaiton level})$$

e. Classification

ISC Score	Socioeconomic group
8 - 35	Upper Socioeconomic group
36 - 64	Lower socioeconomic group

Form -ISC-1

Appendix - 4

ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

(Department of Psychology)

INDEX OF SOCIOECONOMIC CHARACTERISTICS

1. This index is developed inorder to collect information on socioeconomic positions. The information will be used for research purposes in the study to examine the relationship between socioeconomic positions and General Mental ability. The information obtained will be kept confidential and will not affect anybody. There is no need to write names. Please give your response frɔnkly and honestly so that the result will be valid enough. Your sincere responses will be highly appreciated.

2. The index has two parts only. The first part is occupation and the second is educaiton level. Each part has eight categories. You are supposed to select your current occupation and the education level you completed from the categories arranged in order from higher to lower level.

Thank you.

Subject's Code No. _____

School _____

Grade level _____

Sex _____ Age _____

General Instruction - Below are given types of occupation in part I and Educaiton level in part II. Each part has eight categories. Please select your Father's or Guardian's occupation and Educaiton level and Show your sincere response by circling one of the eight categories in each part.

PART I TYPE OF OCCUPATION

1. Professional and Technical
2. Administrative and managerial
3. Clerical and related works
4. Sales works
5. Services works
6. Agriculture, animal husbandry & forestry
7. Production, Transport Operation and Labour Works
8. Unemployed and Retired

PART II EDUCAITON LEVEL

1. Higher degrees of specialization
   Doctorate degree, Mastrate degree
2. First degree
3. 1-3 years of University or College Education
4. Technical, Vocational or Secondary Education
5. 7-11 years of Secondary School Educaiton
6. Primary School Educaiton
7. Basic Education
8. No Education

Appendix - 5

Reliability Estimation for the

Index of Socioeconomic Characteristics

Code of Subjects	Score on index 1 (x_1)	Weighted Score $5(x_1)$	Score on index 2 (x_2)	Weighted Score $3(x_2)$	Total Score (x_T)
01	5	25	5	15	40
02	7	35	5	15	50
03	5	25	3	9	34
04	7	35	5	15	50
05	5	25	3	9	24
06	8	40	5	15	55
07	8	40	8	24	64
08	7	35	7	21	56
09	5	25	6	18	43
10	3	15	4	12	27
11	5	25	3	9	34
12	5	25	6	18	43
13	8	40	5	15	55
14	4	20	3	9	29
15	8	40	5	15	55
16	5	25	8	24	49
17	5	25	6	18	43
18	8	40	8	24	64
19	7	35	3	9	44
20	3	15	3	9	24
21	8	40	6	18	58
22	2	10	5	15	25
23	2	10	2	6	16
24	8	40	8	24	64
25	8	40	5	15	55
26	7	35	7	21	56
27	5	25	5	15	40
28	8	40	6	18	58
29	8	40	4	12	52
30	8	40	6	18	58

$$\Sigma (SD_1)^2 = (SD_{x1})^2 + (SD_{x2})^2$$

$$= 103.44828 + 26.12069$$

$$= 129.56897$$

$K = 2$

$\Sigma x_T = 1365$

$\bar{x}_T = 45.5$

$SDx_T = 13.579269$

$(SD_{x_T})^2 = 184.39655$

$$\text{Coefficient alpha } (\gamma\alpha) = \frac{(K)}{K-1} \quad 1 - \frac{\Sigma (SD_j^i)^2}{(SD_{x_T})^2}$$

Where K = Number of indices

$(SD_j^i)^2$ = Sum of the Variance of each index

(SD_{x_T}) = Variance of the total score

$$\gamma\alpha = \frac{(2)}{2-1} \quad 1 - \frac{129.56897}{184.39655}$$

$= 2\ (1 - 0.7026648)$

$= 2\ (0.2973351)$

$\gamma\alpha = 0.5946703$

Appendix - 6

1. Paire-wise comparisons of Meðns between Grades 7,9 and 11 for one-way ANOVA

Group	Grade 7	Grade 9	Frade 11
$\bar{x}_j$	28.51	34.10	35.5
n_j	70	290	239
$c_1 = \mu_1 - \mu_2$	1	-1	0
$c_2 = \mu_1 - \mu_3$	1	0	-1
$c_3 = \mu_2 - \mu_3$	0	1	-1

$$F = \frac{\Sigma(c_j \bar{x}_j)^2}{(MS_W)\left[\Sigma(c_j^2/n_j)\right]}$$

Where $\sum_{j=1}^{k} c_j = 0$

$\bar{x}_j$ = Meðns of each group

MSW = Meðn square within cells

n_j = Sample size of each group

$$F_1 = \frac{(28.51 - 34.1)^2}{172.77\left(\frac{1}{70} \times \frac{1}{290}\right)}$$

$$= \frac{31.2481}{3.0639}$$

$$= 10.199$$

$$F_2 = \frac{(28.51 - 35.5)^2}{172.77\left(\frac{1}{70} + \frac{1}{239}\right)}$$

$$= \frac{48.8601}{3.191}$$

$$= 15.3117$$

$$F_3 = \frac{(34.1 - 35.5)^2}{172.77\left(\frac{1}{290} + \frac{1}{239}\right)}$$

$$= \frac{1.96}{1.319}$$

$$= 1.486$$

$$F_{cv} = (K-1)\ (F_{cv}\ (.05))$$

Where K = Number of groups

F_{cv} (.05) for df 2,596 = 3.01

$$F_{cv} = (3-1)\ (3.01)$$

$$= 6.02$$

Therefore meon differences between grades 7 and 9 and grades 7 and 11 are statistically significant at .05 level while the mean difference between grades 9 and 11 are not significant at the same level.

2. For two-way ANOVA (between Type of Schooling and Grade Level)

$$MS_w = 154.87$$

$$F_1 = \frac{(28.51 - 34.1)^2}{154.87 \left(\frac{1}{20} + \frac{1}{290}\right)}$$

$$= \frac{31.2481}{2.746}$$

$$= 11.378$$

$$F_2 = \frac{(28.51 - 35.5)^2}{154.87 \quad \frac{1}{70} + \frac{1}{239}}$$

$$= \frac{48.8601}{2.86}$$

$$= 17.08$$

$$F_3 = \frac{(34.1 - 35.5)^2}{154.87 \quad \frac{1}{290} + \frac{1}{239}}$$

$$= \frac{1.96}{1.182}$$

$$= 1.658$$

$$F_{cv} = (K-1) \quad (F_{cv} \ (.05))$$

$$F_{cv} \ (.05) \text{ for df } 2,593 = 3.01$$

$$F = (3-1) \ (3.01)$$

$$= 6.02$$

Therefore meon difference between grades 7 and 9 and grades 7 and 11 are statistically significant at .05 level while the meðn difference between grade 9 and 11 are not different for statistical purposes.

3. For two-way ANOVA (between SES and Grade level)

$$MS_w = 165.63$$

$$F_1 = \frac{(28.51 - 34.1)^2}{}$$

$$= \frac{31.2481}{2.9373}$$

$$= 10.64$$

$$F_2 = \frac{(34.1 - 35.5)^2}{165.65 \left(\frac{1}{290} + \frac{1}{239}\right)}$$

$$= \frac{1.96}{1.264}$$

$$= 1.55$$

$$F_3 = \frac{(28.51 - 35.5)^2}{165.63 \left(\frac{1}{70} + \frac{1}{239}\right)}$$

$$= \frac{48.8601}{3.0592}$$

$$= 15.972$$

$$F_{CV} = (K-1)\ (F_{CV}\ (.05)$$

$$F_{CV}\ (.05) \text{ for df } 2,593 = 3.01$$

$$F_{CV} = (3-1)\ (3.01)$$

$$= 6.02$$

Therefore, mean differences exist between grades 7 and 9 and grades 7 and 11 which are statistically significant at .05 level. But grades 9 and 11 are not different in their means for statistical purposes.

4. For two-way ANOVA (between Grade level and Sex)

$$MS_w = 172.04$$

$$F_1 = \frac{(28.51 - 34.1)^2}{172.04 \left(\frac{1}{70} + \frac{1}{290}\right)}$$

$$= \frac{31.2481}{3.051}$$

$$= 10.24$$

$$F_2 = \frac{(28.51 - 35.5)^2}{172.04 \left(\frac{1}{70} + \frac{1}{239}\right)}$$

$$= \frac{48.8601}{3.178}$$

$$= 15.38$$

$$F_3 = \frac{(34.1 - 35.5)^2}{172.04 \left(\frac{1}{290} + \frac{1}{239}\right)}$$

$$= \frac{1.96}{1.313}$$

$$= 1.493$$

$F_{cv} = (K-1)\ (F_{cv}\ (.05)$

F_{cv} (.05) for df 2,595 = 3.01

$F_{cv} = (3.01)\ (3.01)$

$= 6.02$

Therefore, except for the grades 9 and 11 the remaining mean comparison between the grade levels are significant at .05 level.

Appendix - 7

Tests for Significance of Mean differences between

a) Government and Non-Government Schools;

b) Upper and Lower S E S;

c) Male and Female Subjects.

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\left[\frac{(n_1 - 1)\, S_1^2 + (n_2 - 1)\, S_2^2}{n_1 + n_2 - 2}\right] \frac{1}{n_1} + \frac{1}{n_2}}}$$

Where $\bar{x}_1$ = mean score of sub-group$_1$

$\bar{x}_2$ = mean score of sub-group$_2$

n_1 = sample size of sub-group$_1$

n_2 = sample size of sub-group$_2$

S_1^2 = variance of sub-group$_1$

S_2^2 = variance of sub-group$_2$

d = .05 df = 597

a) Government Schools

$\bar{x}_1$ = 32.42

S_1^2 = 177.96

n_1 = 515

Non-Government Schools

$\bar{x}_2$ = 43.74

S_2^2 = 59.91

n_2 = 84

$$t = \frac{32.42 - 43.74}{\sqrt{\left[\frac{(515-1)\ 177.96 + (84.1)\ 59.91}{515 + 84.2}\right] \frac{1}{515} + \frac{1}{84}}}$$

$$t = \frac{-11.32}{1.4958}$$

$$t = -7.5679$$

$t_{cv}\ (.05) \pm 1.96$ for df = 597

b) Upper SES

$\bar{x}_1 = 37.99$

$S_1^2 = 154.75$

$n_1 = 270$

Lower SES

$\bar{x}_2 = 30.74$

$S_2^2 = 171.35$

$n_2 = 329$

$$t = \frac{37.99 - 30.74}{\sqrt{\left[\frac{(270 - 1)\ 154.75 + (329 - 1)\ 171.35}{270 + 329 - 2}\right] \frac{1}{270} + \frac{1}{329}}}$$

$$= \frac{7.25}{1.0512}$$

$t = 6.897$

$t_{cv}\ (.05) \pm 1.96$ for df = 597

c) Male Subjects

$\bar{x}_1 = 34.95$

$S_1^2 = 181.17$

$n_1 = 319$

Female Subjects

$\bar{x}_2 = 32.93$

$S_2^2 = 170.04$

$n_2 = 280$

$$t = \frac{34.95 - 32.93}{\sqrt{\left[\frac{(319-1)\ 181.17 + (280-1)\ 170.04}{319 + 280 - 2}\right] \frac{1}{319} + \frac{1}{280}}}$$

$$= \frac{2.02}{1.086}$$

$t = 1.859$

$t_{cv}\ (.05) \pm 1.96$ for df = 597

Appendix - 8

Tests for the Significance of Correlations

a) Tests for Significance of simple correlations between SPM Test scores and

a.a) Type of Schooling with r = .2959

a.b) SES with r = .2497

a.c) Grade level with r = .1193

a.d) Sex with r = .0761

$$t = r\sqrt{\frac{n-2}{1-r^2}}$$

Where r = the observed correlation cofficient

n = sample size

= .05

df = 597

a.a) Type of Schooling

$$t = .2959\sqrt{\frac{599-2}{1-.2959^2}}$$

$$= 7.5688$$

a.b) SES

$$t = .2497\sqrt{\frac{599-2}{1-.2497^2}}$$

$$= 6.3006$$

a.c) Grade level

$$t = .1193\sqrt{\frac{599-2}{1-.1193^2}}$$

$$= 2.9359$$

a.d) Sex

$$t = .0761\sqrt{\frac{599-2}{1-.0761^2}}$$

$$= 1.8648$$

t_{cv} (.05) $\pm$ 1.96 for df = 597

b) Test for Significance of Multiple Correlation between SPM Test and Test and the treatment variables

Multiple R = .3538 = .05 df = 1,594

$$F = \frac{R^2/k}{(1-R^2)/((n-k-1)}$$

Where K = number of treatment variables
R = multiple correlation coefficient observed
n = sample size

$$F = \frac{.3538^2/4}{1-.3538^2/599-4-1}$$

$$= \frac{.0312936}{.8748255/594}$$

$$= \frac{.0312936}{.0014727703}$$

$$F = 21.24812$$

F_{cv} (.05) = 3.86

c) Test for significance of partial-correlations between SPM Test score and

c.a) Type of schooling with partial r = .2337

c.b) S E S with partial r = .1734

c.c) Grade level with partial r = .1051

c.d) Sex with partial r = .0734

$$t = \frac{r_{yx_1 \cdot x_2 \cdot x_3 \cdots x_p}\sqrt{N-2-v}}{\sqrt{1-r^2_{yx_1 \cdot x_2 \cdot x_3 \cdots x_p}}}$$; Where N = Sample size

V = number of independent variables partialled out

$r_{yx_1 \cdot x_2 \cdot x_3 \cdots x_p}$ = partial correlation coefficient of variable x_1

= .05 ; df = 593 , t_{cv} (.05) $\pm$ 1.96

c.a) $$t = \frac{.2337\sqrt{599 - 2 - 3}}{\sqrt{1-.2337^2}}$$

$$= \frac{5.6957633}{.97231}$$

t = 5.8579705

c.b) $$t = \frac{.1734\sqrt{599-2-3}}{\sqrt{1-.1734^2}}$$

$$= \frac{4.2261248}{.985}$$

t = 4.290482

c.c) $$t = \frac{.1051\sqrt{599-2-3}}{\sqrt{1 - .1051^2}}$$

$$= \frac{2.5615093}{.99446}$$

t = 2.5757791

c.d) $$t = \frac{.0734\sqrt{599-2-3}}{\sqrt{1 - .0734^2}}$$

$$= \frac{1.7889133}{.9973}$$

t = 1.7937564

D E C L A R A T I O N

I, the undersigned declare that the thesis is my original work and has not been presented for a degree in any other University and that all sources of material used for this thesis have been dully acknowledged.

Name: Fisseha Mekonnen

Signature: Fisseha Mekonnen

Place: Addis Ababa University

Date of Submission: 8th June, 1992.