

DIFFERENTIAL VALIDITIES OF SELECTED
VARIABLES IN THE PREDICTION OF
COLLEGE SUCCESS FOR BLACKS
AND WHITES

Thesis for the Degree of Ph. D.
MICHIGAN STATE UNIVERSITY
ANTHONY K. KALLINGAL
1970



This is to certify that the

thesis entitled

DIFFERENTIAL VALIDITIES OF
SELECTED VARIABLES IN THE PREDICTION OF
COLLEGE ACHIEVEMENT FOR BLACKS AND WHITES
presented by

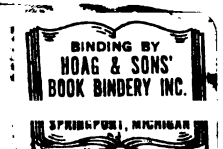
Anthony K. Kallingal

has been accepted towards fulfillment
of the requirements for

Ph.D. degree in Educational Psychology

A handwritten signature in dark ink, appearing to be "AK" or similar, written over a horizontal line.

Date August 3, 1970



~~NOV 8 1971~~ 322

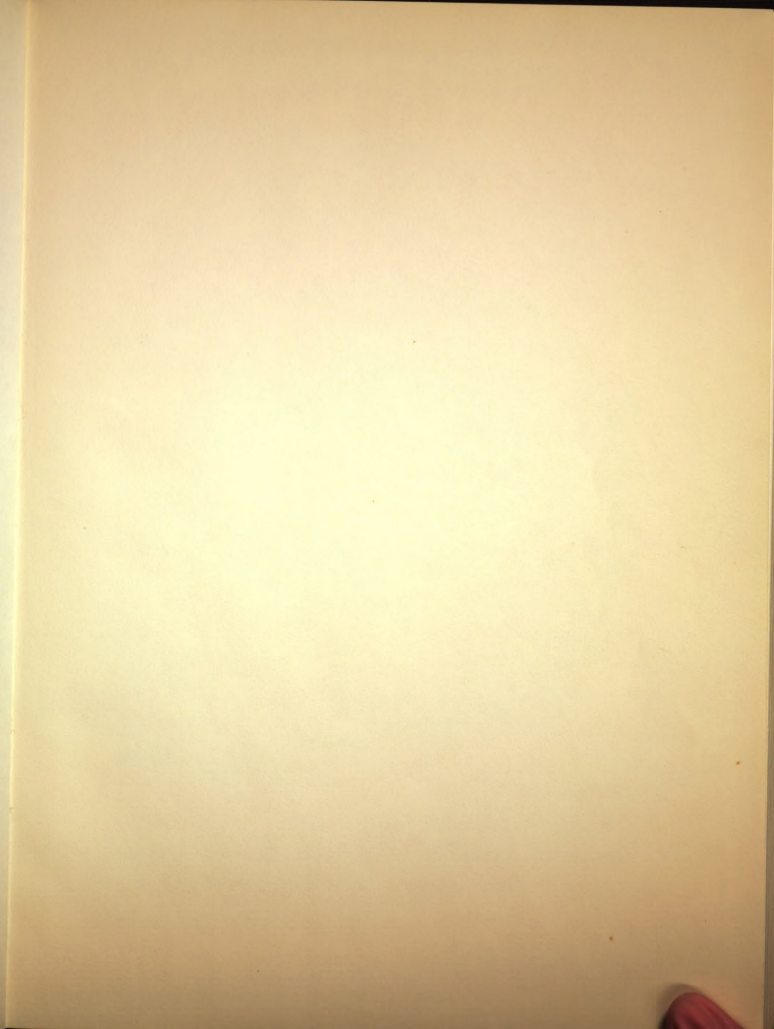
~~MAR 30 1972~~ R51

~~APR 15 1972~~ 276

~~JULY 2 1972~~ 185

~~MAR 28 1974~~ 206

~~JUL 18 1974~~ 191



question 2. How much of the criterion variance in the case of blacks is explained by the use of aptitude tests, and the use of high school GPA is restricted to the aptitude variables and is not very high.

ABSTRACT

DIFFERENTIAL VALIDITIES OF SELECTED VARIABLES IN THE PREDICTION OF COLLEGE SUCCESS FOR BLACKS AND WHITES

by Anthony J. Hallinan

This study will attempt to answer two research questions:

1. Is the aptitude test prediction applicable to blacks and whites who are not both? Do the scales and linear regression are applicable to both groups? The same rule of prediction will be applicable to blacks and whites only if the regression surfaces represented by the equations for these two groups are homogeneous. Thus the question becomes: Are the regression surfaces for blacks and whites homogeneous? The ultimate aim was to discover whether the use of aptitude test scores with the same regression equation to predict college success for blacks and whites would be biased against blacks.

2. How much of the criterion variance is explained by the aptitude variables in each of the two groups? Is there a significant difference in the multiple correlation coefficients between the criterion and the aptitude variables for the two groups?

3. Can the accuracy of prediction in the case of blacks be improved by the use of curvilinear models, by the use of high school GPA in addition to the aptitude variables and by the use of ABSTRACT for variables?

The samples selected for the study were from the population of State University in the fall of 1970. AND WHITES completed the 1970 winter term.

by Anthony K. Kallingal

This study explored three major research questions:

1. Is the same rule of prediction applicable to blacks and whites when aptitude test variables and linear regression are to predict college success? The same rule of prediction will be applicable to blacks and whites only if the regression surfaces represented by the equations for these two groups are homogeneous. Thus the question becomes: Are the regression surfaces for blacks and whites homogeneous? The ultimate aim was to discover whether the use of aptitude test scores with the same regression equation to predict college success for blacks and whites would be biased against blacks.

2. How much of the criterion variance is explained by the aptitude variables in each of the two groups? Is there a significant difference in the multiple correlation coefficients between the criterion and the aptitude variables for the two groups?

3. Can the accuracy of prediction in the case of blacks be improved by the use of curvilinear models, by the use of high school GPA in addition to the aptitude variables and by the use of moderator variables?

The samples selected for the study were from the population of freshmen who entered Michigan State University in the fall of 1968 and who completed the 1970 winter term. Sample one consisted of all black students who had complete data for various comparisons. For one set of comparisons the black sample was 224 and for another set of comparisons it was 216. Sample two consisted of students randomly chosen from the white population. Its size for one set of comparisons was 511 and for another 268.

The principal instruments in the study were MSU English, MSU Reading, and the College Qualification Test (CQT) with three subtests of Verbal, Informational and Numerical abilities. The scores on these tests were used in multiple regression to predict college success defined in terms of the cumulative GPA at the end of the 1970 winter term and a test score GPA which was based on the grades received in the basic college courses taken during the same period. The basic college courses included courses in American Thought and Language, Humanities, Natural Science, and Social Science.

After establishing the fit of the linear model in regression, the two groups were compared in terms of the regression functions and the proportion of criterion variance explained by aptitude variables. These comparisons were made using the cumulative GPA and the test score GPA. Improved prediction accuracy in the case of blacks was attempted by exploring the possibility of the use of curvilinear regression, by the use of high school GPA in addition to the aptitude variables, and by the use of moderator variables. The moderator variables were not used in the regression equation but as basis for identifying homogeneous subgroups in terms of increased prediction accuracy.

The major statistical tools employed in the study were factor analysis, Z tests, and Variance Ratio Tests. The decision rule in all tests was to reject the null hypothesis at a = .05 level of type I error.

Results showed that the regression equations for the two groups were significantly, though not substantially, different. The regression equation for blacks predicted criterion values that were slightly lower than those that would be predicted from the white or common regression equation. Thus it was concluded that the use of a common regression equation for predicting college success of blacks and whites would not be biased against blacks. It was anticipated that the relatively rich environment of an

integrated university like Michigan State would improve the academic achievement of blacks; and, hence, prediction from common regression would result in underestimates of criterion values. Irrelevancy of curriculum and lack of special intervention techniques to compensate for earlier disadvantages might account for the lack of expected improvement in the academic achievement of blacks. The partitioning procedure in which the overall proportion of explained variance was partitioned into parts attributable to individual factors revealed the differing contributions of Verbal Ability Factor and Numerical Ability Factor. Verbal Ability Factor was more important in the prediction of both criteria for blacks than for whites, and Numerical Ability Factor was more important in the prediction of the test score GPA for whites than for blacks.

Both groups were found to be equally predictable in terms of the cumulative GPA. In the white sample studied, twenty-eight percent of the criterion variance was accounted for by the aptitude variables and in the black sample twenty-eight percent of the criterion variance was explained by the aptitude variables. The test score GPA of the blacks were better predicted than the test score GPA of the whites. In the black sample fifty-nine percent of the criterion variance was explained by aptitude variables, whereas in the white sample only

forty-three percent of the criterion variance was explained by the aptitude variables.

An examination of scatter diagrams showed that curvilinear models held no promise of improving prediction accuracy over that achieved by linear model. The addition of high school GPA to the set aptitude variables resulted in six percent improvement with respect to the criterion variance explained by the aptitude variables. The six percent improvement was found to be statistically significant. Sex and intra-individual variability index were effective as moderator variables. Females were better predicted than males with respect to the cumulative GPA, but not the test score GPA. Both criteria were better predicted for the low intra-individual variability group than for high variability group.

Michigan State University

in partial fulfillment of requirements
for the degree of

DOCTOR OF PHILOSOPHY

College of Education

1972

ACKNOWLEDGMENTS
DIFFERENTIAL VALIDITIES OF SELECTED
VARIABLES IN THE PREDICTION OF
COLLEGE SUCCESS FOR BLACKS
AND WHITES

My most indebted to my major advisor, Dr. Robert C. Craig, who has been a source of constant encouragement and By port throughout my doctoral program. Special thanks are extended also to the other members of the dissertation committee, Dr. Mary Ellen McSweeney, Dr. John A. and Dr. James Parker for their constructive criticism.

Special thanks are also due to Dr. Lawrence Lesotte and Dr. Arvo K. for their help in gathering the data for this dissertation. Thanks are also due to Dr. Willard G. for making the facilities of the Office of Evaluation available for my use during this project.

A THESIS

Submitted to
Michigan State University
George, in partial fulfillment of the requirements
for the degree of
of my graduate study.

DOCTOR OF PHILOSOPHY

College of Education

1970

ACKNOWLEDGMENTS

My most sincere thanks are expressed to my major advisor, Dr. Robert C. Craig³⁶³⁷, who has been a source of constant encouragement and support throughout my doctoral program. Sincere thanks are extended also to the other members of the doctoral committee, Dr. Mary Ellen McSweeney, Dr. Dale Alam and Dr. James Parker for their constructive criticism.

Special thanks are due to Dr. Lawrence Lezotte and Dr. Arvo E. Juola for their help in gathering the data for this dissertation. Thanks are also due to Dr. Willard G. Warrington for making the facilities of the Office of Evaluation Services available for my use during this project.

Finally I thank my wife, Leela, and my brother, George, for their help and support during the three years of my graduate study.

III METHODOLOGY

Population and Samples
Instrumentation and Criteria
Research Design
Statistical Hypotheses

Chapter	Page
Statistical Analyses	68
Summary	70
IV ANALYSIS OF	72

TABLE OF CONTENTS

	Page
ACKNOWLEDGMENTS	ii
LIST OF TABLES	v
LIST OF FIGURES	vii
Chapter	
I INTRODUCTION	1
Statement of the Problem	1
Definition of the Terms	4
Theoretical Considerations	6
Need for Separate Rules of Prediction	6
Improvement of Prediction	12
Assumption of Linearity in Prediction	13
Moderator variables in Prediction	15
Purpose of the Study	17
Hypothesis in the Study	19
Limitations of the Study	20
Summary	23
II REVIEW OF THE LITERATURE	25
Introduction	25
Earlier Studies on Prediction:	
A Brief Summary	26
Comparison of Predictive Validities	
for Blacks and Whites	27
Attempts to Improve Prediction	40
Use of High School GPA	41
Use of Alternate Models	43
Use of Moderator Variables	43
Summary	47
III METHODOLOGY	49
Population and Samples	49
Instrumentation and Criteria	50
Research Design	55
Statistical Hypotheses	65

Chapter	Page
Statistical Analyses	68
Summary	70
IV ANALYSES OF DATA: RESULTS	72
Introduction	72
The Data and its Transformation	73
Assumption of Linearity	79
Homogeneity of Regressions	82
Variances Explained by Aptitude Variables	89
Examination of Curvilinear Relationship	96
Influence of High School Scholarship on Prediction	108
Moderator Variables in Prediction	110
Summary	117
V SUMMARY AND CONCLUSIONS	120
Overview	120
Discussion of Results	124
Suggestions for Further Research	132
BIBLIOGRAPHY	135
4.4	79
4.5	80
4.6	80
4.7	81
4.8	82
4.9	85
4.10	86
4.11	87
4.12	88
4.13	89

4.14. Correlations, Squares of Correlations,
Values of Fisher Z's and of Z-statistic
with the Test Score GPA as Criterion . . . 95

LIST OF TABLES

Tables	Page
2.1 Multiple Correlations of SAT-V, SAT-M, and High School Grades with the Freshmen Grade Point Average for White and Negro Samples	33
3.1 Interrelation Matrix of Test Variables	57
4.1 Means, Standard Deviations and Interrelations of Group I	75
4.2 Means, Standard Deviations and Interrelations of Group II	76
4.3 Rotated Factor Loadings	77
4.4 Correlations of Factors with Criteria	79
4.5 Analysis of Regression - Test for Group I	80
4.6 Analysis of Regression - Test for Group II.	80
4.7 Analysis of Regression - Test for Group I	81
4.8 Analysis of Regression - Test for Group II.	82
4.9 Regression Coefficients and Standard Errors with the Cumulative GPA as Criterion	85
4.10 Regression Coefficients and Standard Errors with the Test Score GPA as Criterion	86
4.11 Analysis of Homogeneity of Regressions on the Cumulative GPA as Criterion	87
4.12 Analysis of Homogeneity of Regressions on the Test Score GPA as Criterion	88
4.13 Correlations, Squares of Correlations, Values of Fisher Z's and of Z-statistic with the Cumulative GPA as Criterion	92

4.1.4	Correlations, Squares of Correlations, Values of Fisher Z's and of Z-statistic with the Test Score GPA as Criterion . . .	95
3.1	Curves Illustrating a Number of Different Types of Mathematical Functions	61
4.1	Scatter Diagram and Regression of the Cumulative GPA on MSU English for Blacks	97
4.2	Scatter Diagram and Regression of the Cumulative GPA on MSU English for Whites	98
4.3	Scatter Diagram and Regression of the Cumulative GPA on MSU Reading for Blacks	99
4.4	Scatter Diagram and Regression of the Cumulative GPA on MSU Reading for Whites	100
4.5	Scatter Diagram and Regression of the Cumulative GPA on CQT-Infomational for Blacks	101
4.6	Scatter Diagram and Regression of the Cumulative GPA on CQT-Infomational for Whites	102
4.7	Scatter Diagram and Regression of the Cumulative GPA on CQT-Infomational for Blacks	103
4.8	Scatter Diagram and Regression of the Cumulative GPA on CQT-Infomational for Whites	104
4.9	Scatter Diagram and Regression of the Cumulative GPA on CQT-Numerical for Blacks	105
4.10	Scatter Diagram and Regression of the Cumulative GPA on CQT-Numerical for Whites	106
4.11	Scatter Diagram and Regression of the Cumulative GPA on CQT-Numerical for Blacks	107

LIST OF FIGURES

Figures		Page
3.1	Curves Illustrating a Number of Different Types of Mathematical Functions	61
4.1	Scatter Diagram and Regression of the Cumulative GPA on MSU English for Blacks	97
4.2	Scatter Diagram and Regression of the Cumulative GPA on MSU English for Whites	98
4.3	Scatter Diagram and Regression of the Cumulative GPA on MSU Reading for Blacks	99
4.4	Scatter Diagram and Regression of the Cumulative GPA on MSU Reading for Whites	100
4.5	Scatter Diagram and Regression of the Cumulative GPA on CQT-Verbal for Blacks	101
4.6	Scatter Diagram and Regression of the Cumulative GPA on CQT-Verbal for Whites	102
4.7	Scatter Diagram and Regression of the Cumulative GPA on CQT-Informational for Blacks	103
4.8	Scatter Diagram and Regression of the Cumulative GPA on CQT-Informational for Whites	104
4.9	Scatter Diagram and Regression of the Cumulative GPA on CQT-Numerical for Blacks	105
4.10	Scatter Diagram and Regression of the Cumulative GPA on CQT-Numerical for Whites	106
4.11	Scatter Diagram and Regression of the Cumulative GPA on High School GPA for Blacks	107

also have some validity as predictors of academic success (Segel, 1934; Crawford and Burham, 1946; Chauncey and Frederiksen, 1951; and Fishman 1957). The academic success of women is more p

CHAPTER I

INTRODUCTION

certain moderator variables has proved to be useful in identifying homogeneous groups for accurate prediction (Ghisell, 1969).

Statement of the Problem

With the increased demands for intellectual competence in modern society, larger numbers of youth from all segments of society are entering colleges and universities. In this context many educators find that the existing methods of prediction need to be improved so that no student with the potential for success in college is barred unjustly from gaining entrance to an institution of higher learning. As a result, the search for better predictors of college success has been pursued with increased effort during the past two decades.

This increased effort has produced many prediction studies relating to college success. In spite of considerable variability of findings in these studies, certain generalizations appear warranted. Usually high school scholarship, measured either as high school grade point average (GPA) or as high school rank, is found to be the best single predictor of college success, especially in freshman year (Odell, 1927; Travers, 1949; Garrett, 1949; Lutz, 1968). Scholastic aptitude tests

also have some validity as predictors of academic success (Segel, 1934; Crawford and Burham, 1946; Chauncey and Frederiksen, 1951; and Fishman 1957). The academic success of women is more predictable than that of men (Berdie, 1951; Knoell, 1961; and Seashore, 1962). The use of certain moderator variables has proved to be useful in identifying homogenous groups in terms of accurate prediction (Ghiselli, 1960).

The above generalizations about the prediction of college success generally have come under intensive study recently to ascertain whether or not they are equally applicable to certain populations of students, especially disadvantaged blacks. The applicability of these generalizations to the population of disadvantaged black students is of unquestionable importance today because of the increased demand for larger enrollment of minority youth in colleges and universities.

Some educators have doubted that aptitude test scores are as valid for predicting the academic success of the disadvantaged as for the advantaged (Clark and Plotkin, 1963). Most of the black students in universities and colleges come from disadvantaged environments (Fishman et al., 1964). Hence, there is a need to investigate the predictive validities of aptitude measures differentially for blacks and whites. This need appears all the greater in the case of disadvantaged blacks who

are introduced to the relatively richer environment of integrated colleges because of the possibility that the change will improve their academic achievement. This study addresses itself to this problem of differential prediction of college success in integrated colleges, using aptitude measures as predictors.

This problem of differing validities of aptitude tests for predicting college success involves three aspects. First of all it must be ascertained whether or not the same rules of prediction are applicable for both groups. If not, the appropriate rules of prediction must be determined. Finally the amount of criterion variance that is accounted for by aptitude variables individually and collectively in each group should be assessed.

Another generalization accruing from predictive studies is that high school scholarship is usually the best single predictor of college success. But a recent study by Thomas and Stanley (1969) cast serious doubts on the usefulness of high school grades in predicting college success of black students. Unreliability of grade reporting, invalidity of grades in high school, restriction in range, and intergroup differences in personality characteristic were advanced to explain this phenomenon. Further research is suggested in view of the fact that many institutions are relying heavily on high school grades in their selection. As an attempt to respond

to this suggestion, this study investigated the relative improvement in prediction for blacks by combining aptitude predictors and high school grade point average.

Past studies to improve the accuracy of prediction by the use of personality and environmental variables as additional predictors have not, to a large extent, been very successful. Another approach to the use of these variables has been suggested by Ghiselli (1956), namely, as moderator variables. In this study the effectiveness of the use of moderator variables in the case of black students was also examined.

The problem to which this study addressed itself was threefold: the problem of differential predictive validities of aptitude variables, the problem of relative contribution in prediction of high school grades when added to the set of aptitude variables, and the effectiveness of the use of moderator variables in the case of black students.

Definition of Terms

Throughout this manuscript several terms are used repeatedly. In the interest of clarity those terms are defined below.

1. Predictor

The term "predictor" is used to refer to an independent

or antecedent variable that provides information for forecasting an unobserved event. The changes or differences in the predictor variable are associated with changes or differences in the unobserved event. Values of a predictor variable thus afford a basis for prediction of the unobserved event.

2. Criterion

The term "criterion" is used to refer to a dependent or consequent variable which is presumed to be predictable from the predictor variable or variables. A set of observable activities or behaviors that are relevant to the criterion and that potentially can provide measures may be termed the "criterion performance." The scores obtained on an instrument or scale representing the criterion variable are termed "criterion measures."

3. Regression equation

The term "regression equation" is used to refer to the functional form of the relationship between the predictors and the criterion. This is expressed in the form of a mathematical function in which Y , the criterion, is set equal to some expression which contains values on X s, predictors, and certain constants or parameters. The functional form of the relationship may be either linear or curvilinear.

4. Linear model

A linear model or curvilinear model is best understood

in terms of two variables, which can then be readily extended to the case of many variables. If we were to plot the pairs of values of the two variables in a plane where one is measured along the vertical axis and the other is measured along the horizontal axis, the plotted points will reveal a pattern. The pattern may be such that the plotted points will be more or less either along a straight line or along some curve. In the case of a straight line pattern, the functional relationship is said to be linear and the mathematical formula used to express this relationship is referred to as linear model.

5. Moderator variable

The term "moderator variable" is used to refer to a variable, quantitative or qualitative, which improves the usefulness of a predictor or set of predictors by isolating subgroups of individuals for whom that predictor or set of predictors are especially appropriate. A detailed explanation of this term will be provided later in this section.

Theoretical Considerations

Need for separate rules of prediction

Why is it that aptitude tests may not predict college achievement equally well for blacks and whites? Among

the many factors that influence predictive validity of a test in general, some affect predictive validity differentially for blacks and whites. Two factors that have differential influence on predictive validity seem to be crucial to the writer. The first one is the strength of approximation of measured aptitude to the true intellectual potential of the two groups. The second one is the effect of events on the development of intellectual potential during the period that intervenes between measurement of aptitude and measurement of criterion. This may be referred to as differential developmental effect. Prediction with the same rule will be jeopardized to the extent that there is significant discrepancy between the measured capacity and the true intellectual potential of the groups concerned, and to the extent that there is a differential rate of development of the true intellectual potential for one group. These two factors will now be discussed in some detail.

Assuming a satisfactory level of measurement accuracy for both groups, aptitude tests measure the current functional capacity of blacks and whites equally well. In this respect, the aptitude tests cannot be said to be biased against any group even though they point out the existence of deficiencies in blacks. Clifford, (1963, p. 81) a Negro educator, has said: "To disparage testing programs for revealing the inequities which still exist

in the social, the economic, the educational, and the cultural domains of American life is as erroneous as it would be for residents of Bismark, North Dakota, to condemn the use of thermometers as biased, when, as this is being written, the temperature of Bismark is -11 F and in Miami, Florida it is 83 F." Ausubel (1963) has written: "The intelligence test...proposes to measure functional capacity rather than to account for it. If the culturally deprived child scores low on an intelligence test because of the inadequacy of his environment, it is not the test which is unfair but the social order which permits him to develop under such conditions." Ausubel's statement about intelligence tests is equally applicable in the case of aptitude tests.

However, the problem of interest here is not what the aptitude tests measure, but whether the measured capacity provides a fair picture of the innate potential of the groups concerned. As long as there is a significant discrepancy between the measured capacity and the innate potential, there is the possibility of a growth spurt due to changes in the environment.

In the case of most black students, it is safe to assume that the measured capacity does not truly reflect the innate potential because of prior disadvantaged environment. Most black children suffer from disadvantaged environment both at home and at school. Ausubel and

Ausubel (1963) have described the characteristics of the home environment of Negro children that have a detrimental effect upon their ego development. Deutsch (1963) while discussing the learning process of disadvantaged child makes references to the lack of variety of stimulation in the home. The school environment does not seem to be any better for black children than that at home. The majority of Negro students, educated in both urban and rural communities in North and South, have experienced grossly inadequate elementary and high school education (Green, 1969).

The result of a deprived environment both at home and at school is that most blacks score below national norms on aptitude tests. Bloom (1964) has documented the fact that a deprived environment at home and in school will seriously interfere with an individual's performance on aptitude tests. According to Pettigrew (1964), the severely deprived environment of the average Negro child can lower his measured aptitude in two ways. It can act to deter his actual intellectual development by presenting him with such a constricted encounter with the world that his innate potential is barely tapped, and it can act to mask his actual functioning intelligence in the test situation by not preparing him culturally and motivationally for such a middle class task. It is fairly obvious that the functional capacity measured by aptitude tests is not a good representation of the innate potential in black

children and consequently there is the possibility of a growth spurt due to changes in the environment. Prediction will be in error to extent that this growth spurt has really occurred. The second crucial factor affecting predictive validity is related to the nature of intervening events. This class of events is particularly important when the criterion measure is obtained considerably later than the testing of aptitude. If the time interval between the test administration and the criterial assessment is lengthy, a host of situational, motivational and maturational changes may occur in the interim. An illness, an inspiring teacher, a shift in the aspiration level or in the direction of interest, remedial training, an emotional crisis, a growth spurt or retrogression in the abilities sampled by the test - all of these changes intervening between the testing and the point of criterion assessment may decrease the predictive power of the test.

One of the more consistent findings in research with disadvantaged children is the decline in academic aptitude test scores of such children with time (Fishman et al., 1964). The decline is in relation to the performance of advantaged groups. It is plausible to assume that this decline represents cumulative effects of diminished opportunities and decreasing motivation for academic knowledge and skills. When such cumulative effects are not taken into initial aptitude test scores,

consideration, the predictive power of the academic aptitude tests is impaired.

Looking in another direction, the normative interpretation of test results cannot reveal how much the status of underprivileged individuals might be changed if their environmental opportunities and incentives for learning were to be improved significantly. Some evidence for this type of change is apparent in the success of the Boys Club of New York in its educational program, which is designed to give promising boys from tenement districts opportunities to overcome their environmental handicaps through scholarships to outstanding schools and colleges. Although the majority of boys currently enrolled in this program had mediocre aptitude and achievement test scores up to the time they were given scholarships, practically all of the boys have achieved creditable academic success at challenging boarding schools and colleges (Fishman et al., 1964).

A similar reasoning is applicable in the case of black students attending integrated universities like Michigan State University. It appears safe to assume that the University environment is relatively richer and more stimulating than they had previously known. The encounter with this new environment may provide the needed motivation to black students and thus possibly trigger an accelerated growth in their academic potential, enabling them to achieve higher than what would be expected on the basis of their initial aptitude test scores.

If the above two assumptions, namely that of lack of congruity between measured aptitude and the innate potential and that of accelerated growth of academic potential, were to be true in the case of black students attending Michigan State University, then the use of a common rule of prediction for blacks and whites will result in underestimates of achievement for blacks.

An analysis of regression equations computed separately for blacks and whites based on aptitude tests and the GPA at the end of sophomore year would, it was believed, provide empirical evidence for the lack of accuracy in estimating the success of black students from a common regression line and possibly provide evidence of an accelerated growth in the academic potential of the blacks at Michigan State University.

Improvement of prediction

A regression equation computed by least square methods provided a rule to predict achievement with the minimum of error possible within the constraints of data. In statistical terms the sum of squares for error, $\sum (Y - \hat{Y})^2$ where Y is the observed measure and $\hat{Y}$ is the predicted measure on achievement, is minimum in least square prediction. This error reflects the criterion variance that is not accounted for by the predictors. A measure of the remaining variance i.e., explained variance is given by

the square of the correlation between the criterion and the predictors. Past studies have revealed that aptitude tests have average correlations of .50 with college grade point average. Consequently a large part of variance in college GPA is not explained by aptitude tests. There have been varied and repeated attempts to reduce the unexplained variance so as to improve the quality of prediction. These attempts have included procedures such as the addition of high school GPA to the set of aptitude measures, the use of alternate models for prediction, and the use of moderator variables.

The assumption of linearity in prediction

In almost all studies concerning prediction of academic performance, the methods assume linear relationships - that is, they assume that a unit increase in predictor variable will be followed by unit increases (or decreases in the case of negative relationships) in the criterion, and this will occur in the entire distribution of scores. However, when one considers the degree of relationship between ability and performance, he may find that ability measures are predictive at some segments of the range but not at others, and perhaps they are predictive only up to a certain point. As McClelland (1958, p. 12-13) has put it:

Let us admit that morons cannot do good school work. But what evidence is there that intelligence is not a threshold type of variable, that once a person has a certain minimal level of intelligence his performance beyond that point is uncorrelated with his ability? Several studies suggest that if such a minimal level is set fairly high, ability may no longer play a crucial role in success. Ann Roe in her study of eminent scientists has reported intelligence test data showing a wide range from the highest to the lowest person tested. It is true that the average score was very high, but it is equally true that there were several scientists whose tested intelligence was only moderately above average. In other words, given a certain high level of intelligence, it is possible to be one of the world's greatest living scientists.

The lack of linear relationship necessitates considerable computational work. However it is quite possible through techniques of curve fitting to find non-linear regression equations. The simplest of the non-linear regression is the quadratic for describing the relationship between the two variables. Curvilinear relationships are likely when the predictors are intercorrelated.

For the case involving two continuous predictor variables (X_1 , X_2) and a single predictor criterion score, Y' , such as grade point average, a general mathematical solution has been known for some time. The prediction equation as a general polynomial function assumes the form

$$Y' = A_1X_1 + A_2X_2 + A_3X_1^2 + A_4X_2^2 + A_5X_1X_2 + A_6,$$
 where the A's are constants. If A_3 , A_4 , and A_5 are equal to zero, the equation reduces to linear form. The variables X_1^2 , X_2^2 , and X_1X_2 can be treated as separate independent variables, correlated with the criterion variable, and

assigned weights by customary regression techniques (Ezekiel and Fox, 1959). It can also be determined whether the squared and product terms add significantly to the accuracy of prediction obtained by the linear composite.

Moderator variables

Attempts at improving prediction have involved the use of large number of variables and multiple correlation procedures. Improvement in these attempts depends upon the use of predictors that correlate highly with the criterion, but have low intercorrelations with each other. In practice such predictors are hard to find.

Another approach to the improvement of prediction has been suggested by Ghiselli (1956) who advocates the use of moderator variables. The basic idea may be explained as follows. A look at the scatter of points around the regression line in the case of one criterion and one predictor will reveal that some individuals lie close to the regression line and others deviate far from the regression line. Ghiselli raised a simple, but long overlooked question. If those whose scores fall on or near the regression line constitute a specific subsample, the "predictables," and those whose scores do not lie near the regression line constitute another subsample, the "unpredictables," is there a third variable which would differentiate these two groups? Ghiselli called this third

variable the 'moderator variable.' This idea may easily be extended analytically to the case of multiple predictors, where the regression cannot be represented as a line. But as a hyperplane in a non-dimensional space.

The idea of isolating homogenous subgroups in terms of predictability and developing different regression equation for these subgroups has been tried prior to Ghiselli. The terms 'population control variable,' 'modifier variable,' and 'referent variable' have been used instead of the term 'moderator variable.'

A moderator variable may be quantitative or qualitative. In the case of a qualitative variable, the moderating function consists in partitioning the sample into homogenous subsamples in terms of predictability. Separate regression equations may then be computed for each group to maximise the accuracy of prediction. In the case of continuous variables Saunders (1956) has developed a multiple regression model which includes an expression for the moderator variable. This is similar to the ordinary multiple regression procedure, except that the moderator variables need not be correlated with the criterion variable. In this study, moderator variables of the Ghiselli type were used to maximise the accuracy of prediction for blacks.

Purpose of the Study

It was the purpose of this investigation to compare the parameters of regressions of college grade point average (GPA) on aptitude test variables as predictors for black students and white students at Michigan State University and to determine the effectiveness of the use of high school GPA as additional predictor and of the use of moderator variables in prediction of college success. The aims were to discover whether the same rule of prediction is applicable to both groups or not, to assess the amount of criterion variance accounted for by these variables in each group, to determine the differential contribution of each of the aptitude variables in the prediction of success for blacks and whites and to explore the possibility of further reducing the unexplained variance in the criterion. The battery of tests administered to entering freshmen at Michigan State University by the Office of Evaluation Services was the basis for the aptitude variables to be included as predictors. Comparison was made not only of the parameters of the regression on the overall GPA at the end of the winter term 1970 but also on GPA based exclusively on objective test scores in basic college courses. These courses were American Thought and Language 111,112,113, Humanities 241,242,243, Social Science 231,232,233, and Natural Science 191,192, 193.

A test of goodness of fit was made of each of the regression equations to determine whether the linear model is an appropriate method of prediction. In order to determine the possibility of increased prediction accuracy by choice of an alternate nonlinear model each of the predictor variables was plotted against each of the criteria and the resulting diagrams were examined. If the $f(x, \beta)$ is β -nonlinear, then statistical literature terms the model nonlinear, whereas if $f(x, \beta)$ is x -nonlinear, the model is called curvilinear. Here the term nonlinear is used in its generic sense which includes the notion of curvilinearity. Increased prediction accuracy was also attempted by addition of high school grade point average to the set of aptitude variables and by use of moderator variables like sex, intra-individual variability of the test scores in the aptitude test battery, curricular preference, and urban-suburban-rural home background.

The study attempted, therefore, to answer the following questions:

1. Is the same rule of prediction applicable to both black and white students?
2. If not, what are the appropriate rules of prediction for the two groups?
3. How much of the criterion variance is accounted for by aptitude variables?
4. How much can the accuracy of prediction be improved by

4. adding high school GPA as an additional predictor, by introducing moderator variables, or by choosing an alternate regression model?

The answers to these questions will be of benefit to those who decide admission policies and those who are responsible for academic advisement.

Hypotheses in the Study

The following hypotheses were tested in this study. Each of the following hypotheses used two measures of the criterion variable, namely the cumulative GPA and the test score GPA. Instead of repeating each hypothesis in terms of each GPA the common term "college success" is used. However, each hypothesis was tested in terms of the cumulative GPA and the test score GPA.

1. A linear equation is a good model of the relationship between aptitude variables and the college success for both blacks and whites.
2. The parameters of regression equation for predicting the college success at the end of sophomore year from a set of factors derived from aptitude measures are different for blacks from the corresponding parameters for whites.
3. The amount of criterion variance which is predictable from the correlation with aptitude measures is different for blacks from the corresponding measure for whites.

4. The accuracy of prediction of college success of blacks is enhanced: environment and the characteristics of the subjects if high school grade point average is added to the in another set of aptitude measures, and the prediction rule for b. if moderator variables are used to identify homogeneous groups in terms of predictability, specifically: this assumption is violated, the prediction will be (1). Prediction is more accurate for those with low intraindividual variability than those with high variability. (2). Prediction is more accurate for females than for males. (3). Prediction is more accurate for students of suburban origins than those of rural or urban deviate origins. (4). Prediction accuracy differs according to the carried out curricular preference. Information is provided as to whether data violate this assumption or not.

Limitations of the Study

There are certain limitations which must be taken into account when generalizing the results of this study. These limitations have their source in the assumptions of the methods employed in the study and in the selection of the samples. The major qualification of all prediction studies is that the environment and the characteristics of subjects

for whom the prediction rules are to be applied should be similar to the environment and the characteristics of the subjects from whom the prediction rules were drawn. Stated in another way, the effectiveness of the prediction rule for a particular group depends on its similarity of environmental and personality characteristics to the norm group. To the extent this assumption is violated, the prediction will be in error. drawn from a population of students who

enrolled. Another general qualification of prediction studies is the assumption of linearity of relationship between criterion and predictors. The assumption of linearity in the case of two variables means that the line of best fit which specifies the relationship between the predictor and the criterion is a straight line. To the extent that data deviate from linearity, predictions based on a linear model will be in error. A test of the linearity assumption was carried out in this study and therefore information is provided as to whether data violate this assumption or not.

the sub. Another important assumption in prediction studies using regression techniques is that of independent, normally distributed error variable associated with each observation or unit of analysis. The consequences of the violation of this assumption have been discussed by J. Durbin and G. S. Watson (1950), and D. Cochran and G. H. Orcutt (1949). The violation of this assumption affects the sampling distribution of the estimates of regression parameters. In

this study there is no reason to believe that the assumption of independent, normally distributed error variable is violated. However, it might be a point of concern when applying the results of the study to any specific group.

The manner in which the samples for this study were chosen places some restriction on the generalizability of the results. The two groups whose regression parameters were compared were drawn from a population of students who enrolled at Michigan State University in 1968 and who completed their sophomore year in 1970. Thus the samples are not representative of the general population of freshmen entrants. No information is obtained in this study on those who dropped out for one reason or another from the University during the first two years. In terms of generalizability, this study may be characterized as a study of the persisters. The usefulness of the results to admission officers is therefore indirect and limited, since they are more concerned with the problem of discriminating the successful from the unsuccessful than with the problem of differentiation between and within the groups of persistent students.

Another source of limitation is inherent in the factor analytic techniques employed in the study to avoid the problems of multicollinearity. While factor scores can disentangle the "independent" effects of predictors on the criterion, there are certain disadvantages to be borne

in mind. In most cases, there are problems of factor interpretation, because of unclear factor loading patterns. Another disadvantage of factor analytic technique is that the procedure may lead to loss of information in the data. Keith F. Punch (1969, p. 77) expressed this when he said:

The conceptual and operational elegance of a small number of orthogonal predictors does not justify unfair bruising of raw data and the consequent loss of information. This bruising and consequent loss of information occurs when a few of the total number of the principal components are chosen to stand for the entire set of variables. In this study, all the principal components derived from data were used and therefore no bruising and loss of information have occurred.

Summary

This study addressed itself to the problem of whether the generalizations drawn from research studies about the prediction of college success are equally applicable to a subpopulation of students, specifically the disadvantaged blacks. After defining the terms frequently used in this report, theoretical reasons that would indicate the likelihood of differential predictive validities of aptitude variables in the case of blacks and whites in integrated colleges were discussed.

The traditional approach to the improvement of prediction was outlined. Although the use of non-cognitive variables has not shown promise of improving prediction, another approach to the use of these variables was suggested, namely as moderator variables.

Finally, specific hypotheses regarding differential validities and improvement of prediction were formulated and the limitations inherent in the study were spelled out.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

The present study, while not a replication of any previous research, has nevertheless evolved from the experiences of earlier researchers concerned with the prediction of academic performance in general, and specifically from the experiences of those concerned with differential prediction of college success for blacks and whites.

This review of past research experiences relating to the prediction of academic success has three parts. The first provides a short overview of earlier prediction studies. The second reviews the literature that deals with differential prediction. In this section, important studies comparing blacks and whites on predictive power of aptitude, achievement, and other non-intellective variables are summarized. The third part focuses on attempts to improve the quality of prediction.

Earlier Studies on Prediction:
a Brief Summary

The earlier literature contains studies of academic performance at all educational levels, but that pertaining to undergraduates in colleges is particularly voluminous. The use of tests in the selection of applicants for admission and in the prediction of academic success, defined in terms of college grades, has been the most explored topic in educational and psychological research. Segel (1934) had summarized the findings of 23 studies before 1933. Garrett, in his 1949 review, covering the entire literature of nearly two decades, referred to approximately 194 studies. Fishman (1958) reported 580 studies in the years between 1950 and 1958.

Most studies used aptitude test scores and high school grades as predictors of future academic performance. In an earlier review, Cronbach (1949) reported that ability test scores correlated about .50 to .55 with college grade-point averages. More recent studies have not substantially altered this finding. Travers (1959) who cited more than 200 prediction studies in his review, concluded that high school grades are the best single predictor of college success. A summary by Fishman and Pasanella (1960) revealed that most of the prediction studies were limited to a global prediction of either a semester grade-point average or the freshman year grade-point average. A more

recent trend has been to compare subgroups of student populations on predictive validities and to make predictions for different areas of the college curriculum. Another observation that can be made of the earlier studies is that they attempted to predict academic success through the use of a single variable, usually a standardized test.

Bruce (1953) summarizes the past research thus:

Since the early twenties, well over 1,000 studies have been made in an attempt to better understand and cope with the problems of University admissions and failure. About 90 percent of these studies used one variable and calculated zero order coefficients or correlations to determine evidence of predictive value of these variables. Approximately 5 percent of the studies combined two variables and computed multiple coefficients of correlation...About eight studies attempted four or more variables with limited success, but rarely does any one attempt as many as eight independent variables.

More recently, the emphasis has been on the use of a combination of variables. There is a distinct superiority in multivariable prediction over prediction by the use of a single factor. In 1953, Cosand summarized studies of multiple predictors which showed a range of .53 to .83 with a median of .63 in multiple correlations. These correlations point out the advantage of using several predictors rather than a single one.

Comparison of Predictive Validities for Blacks and Whites

Clark and Plotkin (1964) have questioned the applicability of some of the generalizations that have

been drawn from earlier studies on prediction of black students, especially those in integrated colleges. Fishman et al., (1964) have doubted whether academic aptitude tests are as predictive of the college grades of disadvantaged youths, especially blacks, as they are for advantaged youths. An examination of recent studies led Thomas and Stanley (1969) to reappraise the effectiveness of high school grades in predicting college success for a segment of the general population, namely, the black students.

One of the first studies published on the prediction of college grades from aptitude test scores involving a large number of Blacks and Whites was that of Hills in 1964. He analyzed the data from several colleges of the University System of Georgia over a five-year period, from 1958 through 1962. Included among the colleges were the University of Georgia, Georgia Institute of Technology, a number of four-year colleges, and three four-year colleges attended solely by Negroes. SAT-Verbal, SAT-Math, and high school averages were used to predict freshmen average grade. The multiple correlation coefficient was computed for each college for five years. The average R (multiple correlation coefficient) for five years in the three predominantly Negro colleges was .57, while the average R for the predominantly white Georgia Institute of Technology was .58. Restriction in range of SAT scores and curtailed distributions for the predominantly Negro colleges did not appreciably affect the multiple correlations.

Biaggio and Stanley (1964) subjected data reported by Hills and his associates for the four academic years 1959-60 through 1962-63 to analyses of variance after applying a correction for the restricted range in the scores of the Negroes. They found that the correlation of test scores with the freshman grades was significantly higher for the Negroes for SAT-Math and SAT-Verbal than for the Whites. However, when such restriction of range was not considered, it was found that non-Negro females could be predicted significantly better than Negro females, and that there were no significant differences among males.

It is the view of Stanley and Porter (1967) that Biaggio's procedure for correcting r 's for restriction of range caused by truncation of scores explicitly on a predictor variable probably overcorrects. For this reason, comparisons that involve adjusted r 's are based on greater anticipated predictability of freshmen grades within the predominantly Negro colleges than would likely be achieved with an easier SAT-like test. Stanley and Porter suggest another procedure for correction based on extrapolation from a portion of the distribution (central) to the extremities of the distribution. The basic purpose of correction procedures is to estimate the variance that would be obtained if an easier test were to be administered. Only empirical studies, involving easier instruments, can show how good these estimates are. Further light needs to be shed on this problem.

Mckelpin (1965) studied the significance of the predictive validities resulting from the combination of scholastic aptitude test scores and high school average for predicting freshmen grades for the students at the North Carolina College, Durham, which is a predominantly Negro college. Zero order correlations and multiple correlations between preadmission indices (SAT scores and HSA) and first semester average grades were obtained for the freshmen in 1961, 1962, and 1963 (males and females separately). Multiple correlations averaged about .65. They are as high as those usually reported in the literature for college freshmen.

The author draws two conclusions from the results. Firstly, in terms of first semester freshman grades at North Carolina College, SAT scores seem to give a fair appraisal of what to expect of these students. Secondly, while the abilities measured by the SAT have not been developed to any extent in the students tested, the extent to which the abilities have been developed is reliably measured.

Mckelpin's discussion of the results is particularly important and very pertinent to the present study. His conjectural remarks have provided a basis for the theoretical rationale of the present study. Why do the predictive validities for freshmen in Negro colleges look so good, even with the low SAT scores and their restricted

range? The answer seems to reside in relationships that obtain among elements indigenous to both separate high schools and separate colleges. In other words, the answer seems to lie in the perpetuation of similar environments in segregated high schools and colleges. But these predictive validities do not say anything about the likely performance of those students who operate under conditions in which the typical college freshmen in the nation perform.

Munday (1965) studied the American College Testing Program data for five predominantly Negro colleges to determine if the validity of the American College Tests would be adversely affected in colleges whose student body was predominantly Negro. The accuracy of the prediction of college grades for the five schools was described by three types of multiple correlations. The first one is the multiple R resulting from optimally weighting the four ACT tests. The second one is the multiple R derived from optimally weighting four high school grades. The final one is developed by averaging the GPA predictions made by the optimal weighting of tests and those made by optimally weighting high school grades. The major finding was that the ACT scores in combination with high school grades operated with about typical efficiency in these colleges. The conclusion of the study was that if standardized measures of academic ability are culture

bound, as seems likely, this feature does not appear to detract from their usefulness as predictors of academic success.

In order to offset the effect of the restricted range on correlations, a correction was introduced in the study by arbitrarily giving each college the same variance on the ACT composite. As mentioned earlier, this correction is fraught with danger of unduly inflating the predictability of grades from ACT test scores.

A well designed study by Stanley and Porter (1967), using the data reported by Hills, supports the position that academic aptitude tests predict college freshmen GPA equally well for blacks and whites. They extended the Biaggio (1965) study to cover six years, instead of the original four years. In their basic design, there were three classificatory factors: predominant racial composition of colleges (Negro versus Non-Negro), colleges nested within race, and the six years. The analyses of variance of r 's transformed to Fisher z 's were done separately for men and women to test the statistical significance of the main effects of race and year and the interaction of race with year. White males did not differ significantly from Negro males, but white females were significantly better predicted than Negro females. The year effect was significant beyond the .05 level in both, which means the predictability of males and females varied from year to year.

The interaction of race with year was significant at the .05 level for women, but not for men. This seemed to result because white females had about the same r 's from year to year, whereas Negro females fluctuated greatly.

Thus comparisons of zero order r 's involving SAT-Verbal or SAT-Math as the predictor of freshmen grades reveal that the achievement of white women was predicted significantly better than that of NW (Negro Women) by both, whereas the achievement of white men was not predicted significantly better or worse than that of Negro men by either; in fact, freshmen grades of NM (Negro males) were predicted better than those of WM (White males) by SAT-V scores in five of the six years. (Stanley & Porter, op. cit., pp. 209-210)

The best weighted linear composite of SAT-V, SAT-M, and high school grades resulted in average multiple r 's (via mean z 's) for the six years as given in Table 2.1.

TABLE 2.1

Multiple Correlations of SAT-V, SAT-M,
and High School Grades with the
Freshmen Grade Point Average for
White and Negro Samples

	Male	Female
White	.60	.72
Negro	.60	.63

The range in multiple r 's over the six years was between .55 and .69 for Negro women, but those for white women were steady across years. The multiple r 's for Negro men varied from .55 to .69.

Thus, in view of the detailed analysis of the Georgia data and several related studies, it seems likely that SAT-type test scores are about as correlationally valid for Negroes competing with Negroes and taught chiefly by Negroes as they are for non-Negroes taught chiefly by non-Negroes. Prediction may be approximately equal for the races within integrated colleges, too, as an investigation in three such institutions suggest. (Stanley and Porter, op. cit., p. 216)

The investigation referred to by Stanley & Porter is that of Cleary (1968). She was checking the statement by Clark and Plotkin (1963) that the academic performance of the college students they studied was far above the level that would be indicated by predictive indices such as SAT scores. A test is biased if the criterion score predicted from the common regression line is consistently too high or too low for members of a subgroup. The test is unfair if the use of the test produces a prediction that is too low. If such a test is used for selection, members of a subgroup may be rejected when they were capable of adequate performance. The samples in her study were drawn from three integrated colleges of which two were from the east and one from the southwest. From each college the samples were selected in the following manner: all the Negro students of one college were selected to form sample one; sample two consisted of white students matched with Negro students on curriculum and class; sample three was randomly selected from the white students of the college. Thus there were altogether nine samples in the study.

The criterion in each school was Grade Point Average (GPA). The predictors were the Scholastic Aptitude Test Verbal (SAT-V) and Mathematical (SAT-M) scores and high school average or rank. Separate regressions were computed using first SAT scores only as predictors and then adding high school rank or average to the set of predictors. According to Cleary, if the regression of the criterion on the test is the same for different groups, then the test cannot be said to be biased in terms of its predictive validity. The regression tests of the analysis of covariance were used to determine the difference in regressions. The calculations were performed by a method due to Beaton (1964). The method of analysis makes it possible to test the hypotheses of equality of slopes and equality of intercepts.

When the SAT scores alone were used as predictors, there was no significant difference in regressions in the two eastern schools. But in the southwest college, the regression lines were significantly different: the Negro students' scores were overpredicted by the use of the white or common regression line. When high school grades or rank-in-class were used in addition to the SAT scores, the degree of positive bias for the Negro students increased. An explanation for this was that many of the students may have attended only partially integrated secondary schools and the grades from predominantly Negro and predominantly white schools may not be comparable.

The last study to be described in this section is that of David D. Sempel (1969). This study was designed to determine if the Cooperative School and College Ability Test (SCAT) can predict future college academic success of Negro college students with the same degree of accuracy as it does for white college students and to discover if the sex factor need be considered in making predictions. The sample consisted of 180 Negroes matched with the Whites on sex, college, and year in school from the University of Missouri, Columbia. A correlation coefficient was computed between SAT total score and cumulative grade point average, and between the high school rank and GPA. In the Negro female group, coefficients were generated that are normally expected with college GPA. No correlation was evidenced in the Negro male group. It was hypothesized that sex is an important consideration when making academic predictions for college students and that it is inappropriate to make academic decisions concerning Negro male students on the basis of his SCAT total score. He concluded the study with an observation on the Clark and Plotkin suggestion that standardized tests are not appropriate for predicting academic success for Negro students and that motivation was a more important consideration. This view, he said, cannot be supported or refuted at this point, but more investigation is needed in view of the fact that the SCAT total score used in the current study

had no correlation with academic success in the case of Negro males.

In contrast to the above findings, Green and Farquhar (1965) observed conspicuous lack of similarity in the correlations of black and white students between high school grades and scores on the School and College Ability Test. Their conclusion was that SCAT scores are not good predictors of high school success for blacks, especially for males. They also found that a test of achievement motivation measured by the Self-Concept of Academic Ability Scale correlated higher with the school grades than with the verbal section of the SCAT. The correlation for males was .36 and for females was .65. These results seem to corroborate the View of Clark and Plotkin (1964) that the standardized tests are not appropriate for predicting academic success for Negro students; rather, that motivation is a more important consideration.

Boney (1966) employed a large number of aptitude and mental ability measures and studied their efficiency in predicting high school grade point average for Negro students in secondary schools. The predictor variables in his study were: the Differential Aptitude Tests, the California Test of Mental Maturity, the Cooperative Ability Tests, the Sequential Tests of Educational Progress, and Junior High School Grade Point Average. He obtained a multiple R of .80 with standard error of estimate of .87

for boys and an R of .82 with standard error of estimate of .89 for girls and concluded that regression equations could be computed in junior high school which would predict high school grades with reasonable accuracy for this population and that Negro students are as predictable as other groups.

All of the studies so far described, except that of Cleary have taken correlation coefficients as a unit of analysis. The similarity of the correlation coefficients between predictors and criterion for the two groups indicates that the accuracy of prediction for both groups is similar. But it does not necessarily indicate that the same rule of prediction can and should be used for these two groups. In other words while the correlation coefficient is similar for both groups, the parameters of the regressions for these two groups may be significantly different. Cleary (1968) noted in her study a difference in the regression lines for black and white students at a southwestern college. But it was a case of overprediction of black students' college grades by use of a common regression line. In order to ascertain whether the same rule of prediction can be applied to both groups - which is of prime concern in this study - further investigation has to be made about the difference in regression parameters.

Moreover, the effect of restricted range on correlations is a disturbing factor in studies comparing the predictive validities for blacks and whites. Biaggio and Munday attempted to correct this influence of the restricted range. But the correction is fraught with the danger of unduly inflating the predictability of the group for which the correction is made. The regression weights in regression equations are less influenced than the correlation coefficient is by restricted range in predictors. Thus a comparison of regression equations appears a more appropriate procedure than the use of the correlation coefficient.

Also, all the studies, except that of Cleary and Sampel, compared black students from predominantly black institutions with white students from predominantly white institutions. These conclusions therefore cannot be extended legitimately to integrated colleges. The environment of the segregated colleges is likely to be a perpetuation of the environment in segregated secondary schools, whereas the environment in the integrated colleges presents a significant contrast to that in segregated colleges. But in Cleary's study, this change in environment did not make any change in regressions for the two groups. However, as she herself admitted, the schools used in the study did not represent the full spectrum of colleges in the United States. General conclusions cannot be reached unless further research is done on other colleges.

Improvement of Prediction

As was mentioned earlier, aptitude tests explain only about one-third of the total variance in the criterion of GPA. Consequently, the use of these tests alone for purposes of prediction will result in considerable numbers of "false positives." This means that many who are judged to be unlikely to succeed would in fact succeed if they were given a chance. Like the alchemists of olden days looking for techniques to change base metals into gold, the psychologists and educators of modern days have been constantly searching for methods which will increase the accuracy of their predictions. These attempts to improve the quality of prediction have included such procedures as the addition of high school grades to the set of predictors, the use of alternate models, the use of moderator variables, and the use of non-cognitive variables. Most of these studies have not been on any subgroup of college students, but on college students in general; however, the study by J. R. Hills and J. C. Stanley (1970) is an exception. They found that the use of easier tests improves the prediction of Negroes' college grades. This was suggested by J. C. Stanley and A. C. Porter: "To predict college grades with an academic test, the paramount consideration is to choose a well-prepared test of appropriate difficulty for the persons tested." (1967, 4, p. 216)

High School GPA

Scholarship in high school has generally been found to be the best single predictor of college success. (Odell, 1927; Travers, 1949; Garrett, 1949; Lutz, 1968) An examination of recent studies shows evidence suggesting that high school grades do not consistently contribute the most to predicting college grades of black students, at least in the case of the male sex; but they do contribute the most in the case of the white students. (Thomas and Stanley, 1969). Munday (1965) reported ACT test superiority over high school average for five southern, primarily black, colleges. Cleary (1968) found that for blacks in integrated colleges high school rank correlated .26 and .17 respectively with GPA. For whites in the same college, high school rank correlated .38 and .30 respectively. Peterson (1968) found that for a primarily black college, the correlations between scholarship in high school and freshmen GPA were much lower than that between the other predictors and college GPA. In two other colleges which Peterson studied, the usually-found trend of high school scholarship superiority in predicting college grades held up. In his study at a predominantly black state college in Mississippi, Funches (1967), using high school GPA and ACT scores as predictors, obtained a correlation of .06 between high school GPA and college GPA, while ACT scores correlated .36 with college GPA.

The invalidity and unreliability of grades in black high schools have been advanced as plausible explanations for the relative ineffectiveness of high school grades in predicting freshmen grade point average of black students (Thomas and Stanley, 1969). Munday speculated: "...the predominant 'press' in black high schools is less academic than in white schools. Indices of achievement (grades) may then reflect less academic emphasis." (1965, p. 117)

One of the sources of the unreliability of grades arises from the variability in grading systems that are prevalent in schools. A student with an "A" grade from one college may be only as able as, or perhaps less able than, a student with a grade of "B" from another school. Various techniques have been employed to correct for this variability while predicting college achievement from school grades. These were discussed by Bloom and Peters (1961). Linn (1966) reviewed the results of several empirical studies that have used 'adjusted' grades to predict academic achievement. His paper considered some of the possible techniques which could be used to make grade adjustments for interschool differences. Most researchers, however, have found that the improvement in predictive validity due to the use of adjusted grades has been discouragingly small.

Alternate Models

D. R. Saunders (1956) developed the moderated regression model and showed that its use does improve prediction accuracy. In his model each parameter in the usual regression equation is expressed as a function of the moderator variable. Disadvantages associated with the use of this model have prevented it from coming into popular use. Other attempts at using alternate models like pattern analysis and configural scoring have been of little value in increasing prediction accuracy. Clifford E. Lunneborg and Patricia W. Lunneborg reported their conclusion of studies on pattern prediction as follows: "...there would seem to be small room for continuing the conjecture that patterns can go above and beyond prediction from simple linear function of original variables." (1967, 4, p. 953)

The studies with alternate models have not been specifically on black students, and therefore the possibility remains that for black students, the traditional linear model of prediction is not suitable.

Moderator Variables

The use of moderator variables has successfully identified subgroups whose achievement can be predicted with greater accuracy. Rather than assuming that prediction errors are random, this approach postulates that there are systematic differences between predictable and

unpredictable individuals. If a third variable, called a moderator variable, can be found which correlates with the degree of predictability, then a subgroup of predictable individuals can be identified. The degree of predictability is usually measured by deviation, in standard score units, of the predicted criterion scores from the actual criterion score. Applying the predictors only to individuals who are predictable, the validity of predictors can be increased. Variables such as sex, anxiety, adjustment, and compulsiveness have been found to identify groups of high prediction accuracy (Seashore, 1962; Malnig, 1964; Hoyt and Norman, 1954; Frederiksen and Melville, 1960).

The earlier studies, using moderator variables, have not been on prediction of academic success. In 1956, Ghiselli investigated the prediction of performance of taxi-drivers. The predictor test was a Tap and Dot exercise; the criterion was rating of job performance, after being on the job for six months. The job applicants had also filled out an Occupational Level Inventory, which he hoped to use as the moderator variable. Before the use of the moderator variable, the predictive validity coefficient was .259. After identifying the group of predictables with the moderator variable, the predictive validity was .660, a large increase from .259.

In a second study, Ghiselli (1960) obtained scores on an intelligence test, rated on a sociability scale and

on an initiative scale, for a group of 232 undergraduates. The validity coefficient of the "intelligence" scores in predicting sociability was .226. Using some of the items in the "initiative" scale to identify a subgroup that could be more accurately predicted with respect to the criterion of sociability, he obtained a predictive validity coefficient of .860.

Brown and Scott (1966) attempted to apply the moderator variable model to a typical academic prediction situation. Study habits, attitudes and personality variables were studied as possible moderators. The results were far from encouraging. In no case did they find a moderator variable that resulted in any significant improvement in validity. One explanation was that the validity of the predictors used in the study were already highly correlated with the criterion. Another explanation was that in selecting only the most predictable subjects the range of variability was affected and thereby the validity coefficient was lowered.

Berdie (1961) investigated intra-individual consistency of group-test performance. His main hypothesis was that both grades and future test scores could be predicted more accurately for students whose scores were consistent through a series of equivalent algebra tests than for students whose scores were inconsistent. Although the results were ambiguous with regard to improvement in

prediction, he demonstrated that intra-individual consistency can be reliably measured.

Reyes and Clark (1968) carried out research to test whether it is possible to predict future grades from present grades more accurately for students who were consistent in their grades than for students who were somewhat erratic. In their study a consistency index did not improve the accuracy of prediction. Their explanation was that the observed differences in intra-individual consistency were primarily due to chance. This points out the need for caution in attributing a moderator effect to variability manifested by a student's academic record.

Before closing this summary of the literature on prediction, a word must be said about the use of non-cognitive variables as additional predictors. Graff and Hansen summarized the studies on non-cognitive variables in relation to academic achievement as follows:

"A thorough review of the literature indicated that many studies of the non-cognitive aspects of achievement have been conducted during the last two decades. Researchers tried to relate social background factors, interests, Rorschach and TAT responses, study habits, and different personality traits to academic achievement. Unfortunately, the results were generally inconsistent or non-significant. Some of the investigations produced correlations similar to those found with conventional predictors of academic success. The crucial issue, however, comes in determining how much these non-intellectual components actually added to the prediction validity based on high school records and intellectual tests. In general, the increase was not large enough to warrant inclusion of personality measures with cognitive factors, particularly if they are to be used for selection purposes." (1970, 11, p. 129).

Therefore the use of non-cognitive variables as additional predictors is not likely to improve prediction and as such they are not used in this study. Investigation of some of the non-cognitive variables as moderator variables is a concern in this study.

Summary

This chapter briefly summarized earlier studies on prediction, reviewed the literature on differential prediction, and examined past attempts to improve prediction.

One of the main characteristics of the earlier studies was that they related one independent variable at a time to the criterion of academic success. These studies have found high school grades and aptitude test scores to be useful in predicting college success. More recently, the trend has been to use a number of variables simultaneously to predict the criterion. Multivariable prediction has demonstrated a distinct superiority over univariate prediction.

Research studies so far, comparing blacks and whites in colleges and universities with respect to predictive validities of aptitude tests reported evidence to show that standardized tests of aptitude predict college success as well for blacks as for whites. The criterion of college success in these studies was either first semester grades or freshmen grades. A need was apparent to relate aptitude

variables to college success at a later time in order to determine the influence on this relationship of the interaction with the university environment.

Literature also indicated a dearth of studies comparing the regression functions which provide rules of prediction. Although the use of non-cognitive variables as predictors has not added to the prediction validity based on high school scholarship and aptitude tests, their use as moderator variables holds out some promise.

CHAPTER III

METHODOLOGY

This chapter consists of descriptions of the population and the samples, instrumentation and criteria, research design, statistical hypotheses, and statistical procedures used to analyze data.

Population and Samples

The study population consisted of all freshmen who entered Michigan State University in Fall, 1968. Registrar's Office records showed there were 7474 new students registered for credit courses at that time, not counting transfer students. When special part-time students, foreign students, and students with incomplete test scores were excluded from the population, 6582 students remained.

The population identified for this study was separated into two strata: black students and white students. Identification of black students was provided by the Center for Urban Affairs, Michigan State University. All other students were assumed to be white students. The black students numbered 302 while the white students

numbered 6,281 after the above mentioned exclusions were made. All black students formed one sample and 609 white students randomly chosen from the rest of the population formed the second sample. The random choice was effected by sorting all data cards according to the last digit of the student number and choosing at random one digit to specify the group. In this case the randomly chosen digit happened to be 4. The predictor variables were derived using these samples. A further cut in the number in each sample was necessary for regression analysis as all students in the selected samples had not completed the winter term, 1970. One of the criteria used in the study was the overall (cumulative) GPA at the end of winter term 1970. The Registrar's Office provided the overall GPA of 226 students in the black sample and 511 students in the white sample.

Instrumentation and Criteria

The purpose of this study was to compare the regression functions for predicting college success of blacks and whites from aptitude variables and to attempt to improve the accuracy of prediction for blacks. The orientation tests administered to almost all freshmen in fall 1968 formed the basis from which the predictor variables were derived. The derivation procedure is in a later section in this chapter. There were two indices of

college success that were used as criteria: the cumulative GPA at the end of the winter term 1970 and a GPA based on standardized tests in the four basic college courses, namely, American Thought and Language (111, 112, 113), Humanities (241, 242, 243), Social Science (231, 232, 233), and Natural Science (191, 192, 193).

Instruments administered to all or most freshmen were Form C of the College Qualification Tests, MSU Reading Test, and MSU English Test. Each student in the samples completed one of the six forms of the Academic Inventory.

The College Qualification Test

The College Qualification Test (CQT) (Bennet, et al., 1957) consists of three ability tests: Verbal containing 75 items, Numerical containing 50 items and Informational containing 75 items. The informational part contains two sections: science and social studies. Separate scores were obtained for each half but not used in this study. Scores for each test were recorded separately.

In the CQT manual (Bennet, et al., 1957, p. 27) total score reliability coefficients of .97 for freshmen males and .96 for freshmen females were found for two state universities. Those coefficients were obtained by using the split-half method, in which scores of odd and even items were compared. Individual test score reliability coefficients for the group ranged from .81 to .75 for men

and .78 to .94 for women. Science and Social Science scores had the lowest coefficients of reliability. Lehmann and Dressel (1963, p. 30) reported a split-half reliability of .93 for the 1958 freshmen at Michigan State University.

The CQT total score seems to have better predictive power for early college achievement than do individual test scores when used separately. Hartnett (1963) indicated that correlations from .50 to .70 seem to be the usual findings when relating total score to early college performance. In one study, Juola (1963) determined that CQT total score was specially useful for predicting a student's first quarter grade point average (GPA).

Michigan State University Reading Test

The MSU Reading Test was developed by the office of Evaluation Services. The test was designed to measure students' ability to comprehend ideas expressed in paragraphs representative of those found in textual materials of various academic areas at Michigan State University.

The test consists of 50 items and is used on a supplementary basis for selecting students for the Preparatory English Program as well as selection into the honors program. The reliability of the test has been estimated on several occasions by the Office of Evaluation

Services to be approximately .80. Lehmann and Dressel (1963, p. 30) obtained a reliability coefficient of .79 on their study population.

Hartnett (1963, p. 62) reports validity coefficients of .35 to .65 for males using academic performance (grades) as the criterion.

Michigan State University English Test

The MSU English Test was developed by the Office of Evaluation Services. The test was designed to measure students' proficiency in grammar and expression. It consists of 38 objective items representing several aspects of English usage and is primarily used to select students requiring assistance in the Preparatory English Program.

Reliability of the test has been estimated on several occasions by the Office of Evaluation Services to be approximately .80.

Academic Inventory

The Academic Inventory was developed by the Office of Evaluation Services to assess high school background, preparation and academic skills of incoming students. It was expected that the University College faculty could determine if the college was adequately and appropriately meeting the needs of entering students by evaluating student responses to items in the inventory.

There were six forms of the inventory. Each consisted of two sections: one with items of non-intellective nature and the other with items of cognitive nature. Items 1 to 23 were identical on all forms. These items related to such things as size of the student's graduating class in high school, size and nature of the community in which his high school was located, and information about courses he took in grades 9 through 12. Some of these common item responses were utilized in this study to develop moderator variables.

Criteria

There were two criteria employed in this study. One was the cumulative grade point average (GPA) at the end of the winter term 1970, and the other was the grade point average on tests in basic college courses, namely American Thought and Language 111, 112, 113, Humanities 241, 242, 243, Social Science 231, 232, 233, and Natural Science 191, 192, 193. Although test scores were available on all courses, the track system introduced in the fall term 1969 made the raw scores non-comparable. Each track in the same course had a different examination from the other tracks and the highest possible scores in these examinations also varied.

Each student received a grade based on his performance on examinations in each course. This examination grade

was combined with instructor's grade in a 40-60 composite form and this composite became the final grade of the student. In this study, only the examination grade was used.

All Humanities and Social Science tests consisted of multiple choice items, but the number of items varied from test to test. The tests in American Thought and Language and Natural Science Courses contained multiple choice items and essay items. The reliabilities of these tests have been estimated every term by the Office of Evaluation Services and KR#20 coefficients ranged from .78 to .92. In estimating the reliabilities of tests containing essay items, computation was based only on objective items.

The basic college course examinations were developed by the Office of Evaluation Services in cooperation with the departmental Examination Committees. The tests were designed to measure students' retention and integration of knowledge accumulated during the term in each of the courses.

Research Design

The problem of comparing blacks and whites on the predictive validities of aptitude variables was broken down into three parts: (1) comparing the linear regression functions for the two groups, (2) comparing the amount

of variance accounted for in the criteria by aptitude variables individually and collectively, and (3) testing the linearity assumption of the regression function.

In any study of comparison of regression functions of different groups, multicollinearity is a potential danger (Blalock, Jr., 1963, Gordon, 1967, and Darlington, 1968). The problem of multicollinearity is associated with the use of correlated independent variables in regression equations. When the independent variables are highly correlated, it is extremely difficult to evaluate their relative importance without running the risk of making faulty inferences. First of all, the numerical value of regression coefficients for a particular sample will fluctuate depending upon which variable is taken first in the regression equation. As the order of independent variables changes, the regression weights will also change. Further, the sampling error of the partial slopes will be quite large. In statistical and mathematical terms, this means that the variance-covariance matrix associated with the regression coefficients is not diagonal when the independent variables are correlated. Since the off-diagonal elements are non-zero, these have to be added to estimate the error associated with each regression coefficient. Thus the estimate of the sampling error will be very large when the variables are intercorrelated.

In this study the independent variables were inter-correlated as shown in Table 3.1.

Table 3.1. Intercorrelation Matrix of Test Variables*

	1	2	3	4	5
Variable 1	1.0000				
Variable 2	.6714	1.0000			
Variable 3	.7088	.7615	1.0000		
Variable 4	.5916	.7016	.7093	1.0000	
Variable 5	.5320	.5180	.4411	.6386	1.0000

*Variable 1 = CQT-Verbal, Variable 2 = CQT-Informational, Variable 3 = CQT-Numerical, Variable 4 = English Efficiency, Variable 5 = Reading

In order to avoid the problems of multicollinearity due to the intercorrelations of the independent variables, the original variables, namely the five tests, were transformed into orthogonal variables by factor analysis. Then scores were computed for each individual in the two samples on the derived orthogonal variables. The computer program, Factor AA, used to generate orthogonal variables and to compute factor-scores for each individual, was originally prepared by Anthony V. Williams, Department of Geography, Pennsylvania State University, and adapted for use on 6500 computer at Michigan State University by James Peterson, Computer Institute for Social Science Research, and Robert Paul, East Moline, Ill. (CISSR, 1969).

The transformation of original variables and scores into orthogonal factors and factor scores did not affect the accuracy of prediction. If the number of factors extracted equals the original number of predictor variables, then it can be shown that the multiple regression equation constructed to predict the criterion variable from the factors is equivalent to the comparable equation constructed from the original variables. The two equations will make identical predictions for any individual (Darlington, 1969, p. 178). In this study the number of orthogonal factors derived from the original variables was equal to the number of original variables. Moreover, the multiple R's between the predicted and observed scores were found to be identical in either case, .5292 for white sample and .5119 for black sample.

In order to compare the regression functions for blacks and whites, the test of homogeneity of regression suggested by Wilson and Carry (1969) was employed. The purpose of comparison was to discover whether the same rule of prediction was applicable to black students and white students. The same rule would not be applicable to both groups if the separate regression equations were not homogeneous.

After determining the need for separate regression equations by which the values of the criterion variable may be estimated from the predictor variables for the two

groups, it is desirable to compare the measures of how closely such estimates agree with the actual values for the two groups. This was done by a comparison of the coefficients of multiple determination, R^2 , for the two groups, where R is the coefficient of multiple correlation which is simply the ratio of the standard deviation of the estimated values to the standard deviation of the actual values (Ezekiel, 1963, p. 188). The R^2 represents the proportion of criterion variance accounted for by predictors. A test of no difference in the multiple correlations will demonstrate whether the proportions of variances accounted for by predictors are the same in the two groups. The same objective can be achieved by a comparison of the conditional variances for the two groups under the assumption of equal criterion variances, but this method was not used in this study.

The coefficient of multiple determination provides a means of determining the overall variance contribution that is attributable to all predictor variables simultaneously. The relative importance of each predictor variable was determined by a partitioning procedure made possible only because the intercorrelated original variables were transformed into orthogonal variables by Principal Components Solution. The sum of squares due to regression is divisible into as many additive parts as there are factors in the case of orthogonal variables. Each additive part

not true

represents the variance accounted for by each factor. Thus transformation of the original variables into orthogonal ones made it possible to compare the relative importance of each factor in the two groups without running the risk of multicollinearity.

Goodness of fit of the linear model

To determine the goodness of the model, the traditional method of testing the null hypothesis that the vector of betas are all zero was used:

$$H_0: \underline{\beta} = \underline{0}$$

Rejection of null hypothesis means that the linear model does provide an appropriate method of prediction. It does not mean that no other model will fit the data either as well or better. Failure to reject the null hypothesis implies that the model does not provide a useful rule of prediction. Therefore in either case of rejection or non-rejection it is reasonable to explore the possibilities of using alternate models.

It is possible to represent relations by curves of various types. There is practically no limit to the different kinds of curves which can be described by mathematical equations. Ezekiel and Fox (1963, p. 70) list the equations of a number of curves which are useful in statistical analysis between two variables:

1. $Y = a + bX + b_2 X^2$
2. $\text{Log } Y = a + bX$
3. $\text{Log } Y = a + b \log X$
4. $Y = a + b \log X$
5. $Y = \frac{1}{a + bX}$
6. $Y = a + bX + b_2 X^2 + b_3 X^3$
7. $Y = a + bX + b_2 (1/X)$

Curves corresponding to these equations are shown in figure 3.1, adapted from Ezekiel and Fox (1963, p. 71).

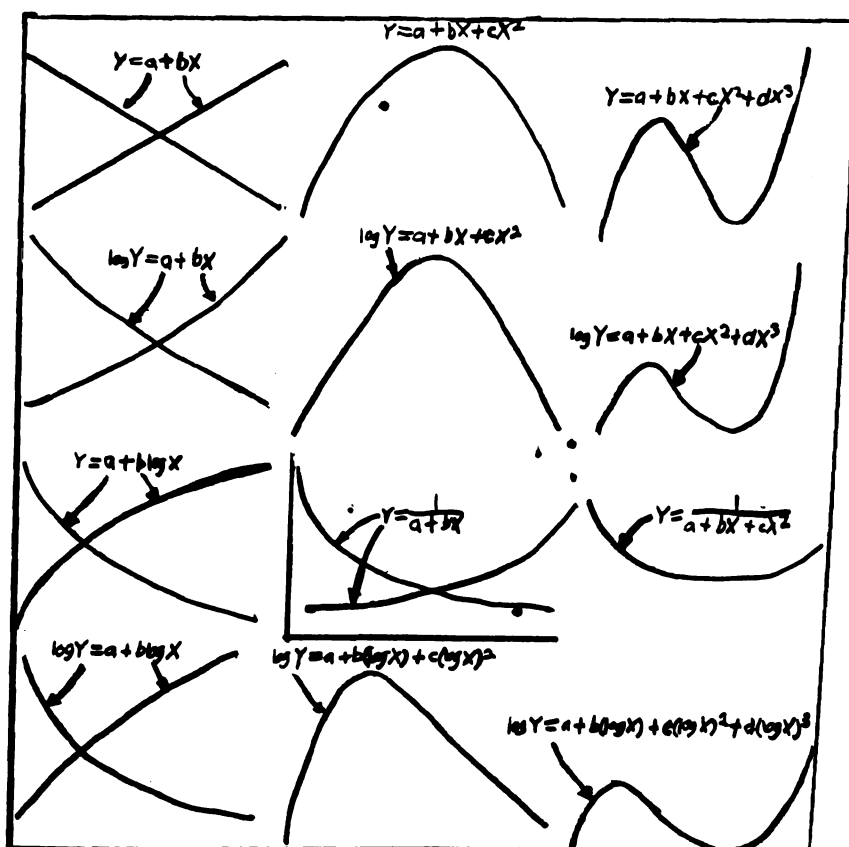


Figure 3.1. Curves illustrating a number of different types of mathematical functions.

Extension to the case of more than one independent variable is easy. The relationship may be expressed in the following general mathematical formula:

$$Y = A + f_1 (X_1) + f_2 (X_2) + \dots + f_n (X_n)$$

Where $f_1 (X_1)$ is a general term expressing the relationship, linear or curvilinear, between the criterion and any particular variable, and A is a constant.

In all these mathematical formulations, there is an implicit assumption that the effect of one independent variable on the criterion is not affected by effect of any other independent variable. In other words, the model is additive. When interaction of independent variables on the criterion is suspected, the equation should consist of, beyond the additive function, an interaction or joint function. For example where two independent variables are involved, it would be:

$$Y = A + f_1 (X_1) + f_2 (X_2) + f_3 (X_1X_2)$$

where $f_3 (X_1X_2)$ is read as "joint function of X_1 and X_2 ."

Although the use of any specific curvilinear model was not attempted in this study, the relationship between the criteria and each of the predictive variables was plotted on a scatter diagram and graphically examined for possible departures from linearity.

High School GPA

In order to assess the contribution of high school scholarship to the prediction of college grade point average and the test score GPA, a new regression equation was computed for blacks with high school grade point average added to the set of aptitude variables as predictors and the multiple R^2 was computed in the case of each. The increment in multiple R^2 over the original R^2 reflects the contribution of high school scholarship in prediction of college achievement in terms of both criteria.

Moderator Variables

Increased prediction accuracy was attempted also by the use of moderator variables such as sex, intended area of college major, home background in terms of urban, suburban and rural origin, and intraindividual variability of sub-test scores in the aptitude test battery.

The entire sample of black students in the study was separated into two subgroups on the basis of each moderator variable. Separate multiple correlations were computed for each subgroup. A significant difference in the correlations indicated the effectiveness of the moderator variable in identifying an homogeneous subgroup in terms of higher predictability.

Sex identification was available on every student in the black sample.

The data on home background were gathered from the responses to an item in the Academic Inventory. The item read as follows:

Which of the following best describes the community in which your high school was located?

1. Within the city limits of a large city (200,000 population or over)
2. Within a suburb of a large city (within 25 miles)
3. Within the city limits of a medium sized city (50,000 to 199,000)
4. Within a suburb of a medium sized city (within 10 miles)
5. Within a small city or town or rural area.

For purposes of this study, this variable was dichotomized. Those who chose alternatives 2 and 3 formed one group and the rest formed another group. Separate multiple R's were computed for each group and examined for significant difference.

Information on the students' major college preference was available from the Office of Evaluation Services in the following specification: 0 for no preference, 1 for Agriculture, 2 for Business, 3 for Engineering, 4 for Home Economics, 5 for Natural Science, 6 for Veterinary Medicine, 7 for Education, 9 for Communication Arts, E for Arts and Letters, N for Social Science, M for Justin Morrill College, L for Lyman Briggs College, and J for James Madison College. This variable of college preference was dichotomized into a preference for physical and natural sciences on the one hand and a preference for

social and behavioral sciences on the other. The following colleges were assigned to the first category: Agriculture, Engineering, Natural Science, Veterinary Medicine and Lyman Briggs College. The rest of the colleges were considered as belonging to the social and behavior science category. The students with no preference were excluded for this comparison.

The index of intraindividual variability employed in this study was computed from the individual test scores in the battery. Scores on individual tests were transformed into standard scores before computing the variance for an individual so as to avoid the danger that the resulting index might be a function of measurement, rather than a reflection of the variability of the individual concerned. On the basis of this individual variability in aptitude test scores, the group was separated into high variability group and low variability group and their correlations were compared.

Statistical Hypotheses

For purposes of statistical tests of significance, the following null hypotheses were formulated from previously stated purposes and substantive hypotheses.

The reader will recall that null hypotheses are not statements of expected outcome of research, but they are statements used in making a decision about rejection or

acceptance of the substantive hypotheses which are statements of expected outcome. Hypothesis Testing asks the question: Under the assumption that the null hypothesis is true, what is the probability of obtaining the statistics on the observed data?

1. The use of linear equation to predict the cumulative GPA does not explain any variance in the criterion.
2. The use of linear regression equation to predict the test score GPA does not explain any variance in the criterion.
3. The parameters of the regression equation for predicting the cumulative GPA at the end of the sophomore year from a set of factors derived from aptitude measures are the same for blacks and whites.
4. The parameters of the regression equation for predicting the test score GPA from a set of factors derived from aptitude measures are same for blacks and whites.
5. The proportion of variance in cumulative GPA that is predictable from the correlation with aptitude measures is the same for blacks and whites.
6. The proportion of variance in the test score GPA that is predictable from the correlation with the aptitude variables is the same for blacks and whites.

7. The accuracy of prediction of the cumulative GPA for blacks is not enhanced by adding the high school GPA to the set of aptitude predictors.
8. The accuracy of prediction of the test score GPA is not enhanced by adding the high school GPA to the set of aptitude predictors.
9. When the cumulative GPA is the criterion, the prediction is equally accurate for males and females in the black population.
10. When the test score GPA is the criterion the prediction is equally accurate for males and females in the black population.
11. When the cumulative GPA is the criterion, the prediction is equally accurate for students of suburban origins as those of urban or rural origins in the black population.
12. When the test score GPA is the criterion, the prediction is equally accurate for students of suburban origins as those of urban or rural origins in the black population.
13. When the cumulative GPA is the criterion, the prediction is equally accurate for those in the black population who chose to major in physical and/or natural sciences as those who chose to major in social and/or behavioral sciences.

14. When the test score GPA is the criterion, the prediction is equally accurate for those in the black population who chose to major in physical and/or natural sciences than those who chose to major in social and/or behavioral sciences.
15. When the cumulative GPA is the criterion, the prediction is equally accurate for those in the black population with low intraindividual variability in the subtests of the aptitude test battery as those with high variability.
16. When the test score GPA is the criterion, the prediction is equally accurate for those in the black population with low intra-individual variability in the subtests of the aptitude test battery as those with high variability.

Statistical Analysis

Factor analysis with varimax rotation transformed the original test variables into orthogonal variables or factors. The computer program, FACTOR AA, (CISSR, 1969) was used to carry out the computations involved. This program provided not only the orthogonal factors, but also factor scores for each individual in the samples. These factors and factor scores were used to develop regression equations for predicting academic success of blacks and whites.

The test of linearity of the regression equation, which is really a test to see whether all betas are zero, was accomplished by analysis of variance (Hays, 1963, p. 520-21).

The parameters of regression equations to predict the cumulative GPA and the average score on college basic courses for blacks and whites were analyzed by tests for homogeneity of regression (Wilson and Carry, 1969).

The proportions of criterion variances that were predicted from aptitude variables in the two groups were analyzed by a two sample Z test on multiple correlations transformed into Fisher Z's (Hays, 1963, p. 532).

The increment in the criterion variance that was accounted for by the predictor variables when the high school GPA was added to the set of aptitude measures was tested for significance by a "Variance-Ratio Test" suggested by Baggailey (1962). The ratio is given by

$$F = \frac{(R_+^2 - R^2) (N - m - 2)}{1 - R_+^2}$$

where R is the multiple correlation involving m predictor and R_+ is the multiple correlation involving m + 1 predictor. The quotient should be referred to an F table with d.f. = 1 for the "greater mean square" and d.f. = N - m - 2 for the "lesser mean square."

Finally, the effectiveness of moderator variables was analyzed by two sample Z tests on Fisher Z transformations on multiple R's (Hays 1963, p. 532).

Summary

The population identified for the study consisted of all freshmen who entered Michigan State University in fall 1968 and completed the winter term 1970. However, a few exclusions were made for one or more of the following reasons: lack of complete data, foreign student status, and part-time status. From the remaining population two samples were drawn. Sample one consisted of all black students, 226 in all, who were identified as such by the Center for Urban Affairs at Michigan State University. Sample two consisted of 511 white students randomly selected from the population.

MSU English, MSU Reading, and the College Qualification Test (CQT) were the principal instruments employed in the study. CQT consists of three ability tests: Verbal, Informational, and Numerical.

Two indices of college success were used as criteria: the cumulative grade point average (GPA) at the end of the winter term 1970 and the grade point average on tests in basic college courses. The basic college courses included Humanities, American Thought and Language, Social Science, and Natural Science.

The design of the study involved the transformation of the original predictor variables into orthogonal factors and comparison of the regression functions of these factors on the criteria for blacks and whites in terms of the regression coefficients and the amount of explained variance. The use of high school scholarship and of moderator variables was also a part of the study.

Testable statistical hypotheses were formulated and analyses specified. Normal variates and Variance Ratios provided the test statistics needed for the analyses. The following chapter will deal with the results of the analyses.

CHAPTER IV

ANALYSES OF DATA: RESULTS

Introduction

The major purposes of this study as described in chapter I were: 1. to compare the regression functions for predicting college success of blacks and whites from aptitude measures, 2. to determine the effectiveness of adding high school GPA to the set of aptitude variables, 3. to assess the effectiveness of sex, curricular preference, home background and intra-individual variability as moderator variables. Specific hypotheses were generated from these purposes regarding the relationship between the predictors and the different criteria: the cumulative GPA at the end of the winter term 1970 and the grade point average on basic college course examinations. The data were analysed by a variety of statistical tests. This chapter is concerned with the results of these tests.

The samples for analyses that used cumulative GPA as the criterion consisted of 224 blacks and 511 whites, whereas the samples for analyses using the test score GPA consisted of 216 blacks and 268 whites. In this chapter,

for the sake of convenience of presentation, the black sample will be referred to as Group I and the white sample as Group II.

In this chapter a brief description of the raw data and its transformation is provided at first. The purpose of the transformation was to make the predictors orthogonal. The advantages of orthogonality were explained at length in chapter III. Next the results of the tests of linearity are presented. A brief discussion of the test of homogeneity of regression is offered before presenting the results of tests performed on the hypotheses regarding homogeneity of regression and variance explained by predictors. This is followed by the partitioning procedure intended to ascertain the contribution of the individual predictor factors and by examination of scatter diagrams intended to detect any curvi-linear relationship in the data. Finally the results of the tests on hypotheses regarding the improvement of prediction by adding high school GPA and by using moderator variables are presented.

The Data and its Transformation

Summary Statistics on Raw Data

The five aptitude tests used in this study to predict college success, defined in terms of the two criteria used, were MSU English, MSU Reading, CQT-Verbal, CQT-Informational, and CQT-Numerical. Tables 4.1 and 4.2 provide

the means, the standard deviations and the intercorrelations of the variables in the study, the aptitude tests, high school GPA, the cumulative GPA, and the test score GPA. The reader should bear in mind that correlations are affected by the range and, therefore, the variance and the standard deviation. In the case of a low standard deviation the obtained correlation coefficient would be an underestimate of the true correlation (Garrett, 1937, p. 323).

The means in tables 4.1 and 4.2 show that none of the groups had scores close to the floor of the tests. The observed variance would not therefore be attributed to chance alone. Although the means for group I were generally lower than for group II on all variables, the standard deviations of MSU English, MSU Reading, CQT-Verbal, CQT-Informational, high school GPA, and test score GPA were higher for group I than for group II.

In both groups MSU Reading scores correlated highest with the cumulative GPA (.47 for both groups) and with the test score GPA (.69 for group I and .57 for group II). CQT-Numerical had the lowest correlations with the cumulative GPA in both groups (.20 for group I and .31 for group II) and with the test score GPA (.46 for group I and .34 for group II). All aptitude tests had higher correlations with the test score GPA in both groups than with the cumulative GPA. But the correlation between high school GPA

and the test score GPA was lower than the correlations between high school GPA and the cumulative GPA in group II whereas the converse was true in group I.

The intercorrelations among MSU English, MSU Reading, CQT-Verbal, and CQT-Informational were generally higher than the intercorrelations among other predictor variables.

Table 4.1. Means, Standard Deviations and Intercorrelations of Group I

Variable	Mean	Standard Devia- tions	Intercorrelations							
			1	2	3	4	5	6	7	8
1	19.05	6.56	1.00							
2	25.31	8.02	.64	1.00						
3	38.52	15.62	.65	.71	1.00					
4	37.53	9.93	.56	.65	.72	1.00				
5	23.99	8.25	.48	.45	.38	.55	1.00			
6	2.82	0.54	.28	.25	.25	.18	.19	1.00		
7	2.27	0.47	.42	.47	.43	.38	.20	.37	1.00	
8	1.73	0.79	.59	.69	.68	.67	.46	.44	.71	1.00

1 = MSU English, 2 = MSU Reading, 3 = CQT-Verbal, 4 = CQT-Informational, 5 = CQT-Numerical, 6 = High School GPA, 7 = the Cumulative GPA, 8 = the Test Score GPA.

Table 4.2. Means, Standard Deviations and Intercorrelations of Group II

Variable	Mean	Standard Devia- tions	Intercorrelations							
			1	2	3	4	5	6	7	8
1	25.40	5.62	1.00							
2	32.94	6.78	.54	1.00						
3	54.96	11.39	.57	.66	1.00					
4	48.15	9.06	.45	.59	.54	1.00				
5	33.28	9.46	.39	.36	.21	.54	1.00			
6	3.19	0.50	.36	.34	.25	.36	.39	1.00		
7	2.72	0.52	.43	.47	.37	.38	.31	.46	1.00	
8	2.65	0.69	.50	.57	.55	.54	.34	.38	.76	1.00

1 = MSU English, 2 = MSU Reading, 3 = CQT-Verbal, 4 = CQT Informational, 5 = CQT-Numerical, 6 = High School GPA, 7 = Cumulative GPA, 8 = Test Score GPA.

Transformation of Data

Since the predictor variables used in this study were intercorrelated a transformation of these variables into orthogonal variables was carried out through factor analytic techniques in order to avoid the problem of multicollinearity. This transformation resulted in five new variables with zero intercorrelations. This section describes summary statistics on the new variables and their relationship to the original variables and to the criteria.

Factor analysis with principal axis solution and varimax rotation extracted five orthogonal variables from the original intercorrelated variables. Table 4.3 provides the final factor loadings on each of the original variables.

Table 4.3. Rotated Factor Loadings

Variable	Factors				
	1	2	3	4	5
1	.2859	-.2380	.8681*	.2594	.2018
2	.3237	-.2191	.2933	.8227*	.2903
3	.8100*	-.1482	.3366	.3395	.3056
4	.2970	-.3339	.2176	.2796	.8214*
5	.1236	-.9225*	.2106	.1746	.2425

*Signifies the highest factor loading.

Variable 1 = MSU English, Variable 2 = MSU Reading, Variable 3 = CQT-Verbal, Variable 4 = CQT-Informational, and Variable 5 = CQT-Numerical.

Factor loading signifies the extent of correlation between the factor concerned and the original variables. Each of the original variables had the highest factor loading on one of the orthogonal factors. MSU English correlated .8681 with factor 3; MSU Reading correlated .8227 with factor 4; CQT-Verbal correlated .8100 with factor 1; CQT-Informational correlated .8214 with factor 5; and CQT-Numerical correlated -.9225 with factor 2. Each of the

factors had a moderate relationship with each of the other four variables ranging from $-.1482$ to $.3366$.

The relationship between a particular factor and all the variables together may be described in mathematical terms as follows:

$$Y_i = A_1X_1 + A_2X_2 + \dots\dots\dots A_nX_n$$

where Y_i refers to a factor

A 's are constants

X 's refer to the original variables

In matrix notation, the above expression reduces to:

$$\underline{Y}_i = \underline{A}' \underline{X}$$

The computer program that transformed the original variables into orthogonal factors also computed scores on each of the factors for each individual in the study. These scores were used to compute regression equations for the two groups. These scores were in standard form with mean 0 and variance 1 for the overall sample. But these statistics differed slightly for the two samples due to sampling error. Table 4.4 gives the correlations between the two criteria and the factors. Sample size for each correlation is given in parenthesis.

Table 4.4. Correlations of Factors with Criteria.

Factor	Group I		Group II	
	Cum. GPA(N)	Test GPA(N)	Cum. GPA(N)	Test GPA(N)
1	.21 (224)	.40 (216)	.05 (511)	.17 (268)
2	.05 (224)	-.14 (216)	-.18 (511)	-.15 (268)
3	.27 (224)	.30 (216)	.28 (511)	.32 (268)
4	.30 (224)	.41 (216)	.31 (511)	.34 (268)
5	.19 (224)	.36 (216)	.19 (511)	.35 (268)

Assumption of Linearity

The problem of comparing blacks and whites on the predictive validities involved comparison of regression equations for the two groups in terms of the coefficients and the amount of variance explained when using the equations. The regression equation computed for each group assumed that the relationship between the criteria and the predictors could be adequately represented by a linear model. The usual test of linearity, namely, that the vector of regression coefficients is a zero vector would show whether the linear model could explain any variance at all in the criterion. In this study, this usual test of linearity was performed on both groups using the two criteria, the cumulative GPA and the test score GPA.

In order to test the assumption of linearity the two null hypotheses were formulated and tested for significance.

Hypothesis 1

The hypothesis for the cumulative GPA was:

The use of linear regression equation to predict the cumulative GPA does not explain any variance in the criterion.

In statistical terms this hypothesis states that the vector of regression coefficients (β) is a zero vector (0). This hypothesis was tested for group I and group II separately.

Table 4.5. Analysis of Regression - Test for Group I.

Source	Sum of Squares	d.f.	F
Due to Regression	12.688	5	15.486*
Error	35.722	218	
Total	48.410	223	

*Significant at less than .005 level of type I error

Table 4.6. Analysis of Regression - Test for Group II.

Source	Sum of Squares	d.f.	F
Due to Regression	38.486	5	39.291*
Error	98.930	505	
Total	137.416	510	

*Significant at less than .005 level of type I error.

The F ratio was significant in each case. Consequently the null hypothesis was rejected and it was concluded that the regression coefficients were not all zero and, therefore, a linear model did explain some of the criterion variance.

Hypothesis 2

The hypothesis for the test score GPA criterion was:

The use of linear regression equation to predict the test score GPA does not explain any variance in the criterion.

This hypothesis states that the regression coefficients are all zero. This was also tested for group I and group II separately.

Table 4.7. Analysis of Regression - Test for Group I.

Source	Sum of Squares	d.f.	F
Due to Regression	12.420	f	15.788*
Error	33.061	210	
Total	45.481	215	

*Significant at less than .005 level of type I error.

Table 4.8. Analysis of Regression - Test for Group II

Source	Sum of Squares	d.f.	F
Due to Regression	13.718	5	13.485*
Error	53.304	262	
Total	67.022	267	

*Significant at less than .005 level of type I error.

The F ratio was significant in each group. Consequently, the null hypothesis was rejected and it was concluded that the regression coefficients associated with the aptitude variables did explain a significant amount of the variance in the test score GPA.

The tests involving both criteria showed that a linear model can be satisfactorily used to estimate values of the cumulative GPA and the test score GPA for blacks and whites from the scores on the aptitude tests that were employed in the study.

Homogeneity of Regression Functions

In order to discover whether the same rule of prediction was applicable to black students and white students, the separate regression equations for the two groups were compared for homogeneity. Since the test for homogeneity of regressions, especially in the case of p predictor variables, $p > 1$, is not very common, a brief explanation of

the principles and procedures involved seems appropriate.

In geometric terms, homogeneity of regression is synonymous with parallelism of regression surfaces. The simplest case involves a dependent variable Y , an independent variable X , and the regression line of Y on X determined for each group. Homogeneity question is the same as: Are the two lines parallel? This intuitive idea can be extended to the general case of p predictor variables, $p > 1$ (Wilson Carey, 1969). When Y , dependent variable, regresses on two independent variables, X_1 and X_2 , then the resulting regression is a plane. In the case of p predictor variables, $p > 2$, the resulting regression is a p -dimensional surface. Here the analytic question of homogeneity of regression becomes: Is there significant variation in the two vectors of p regression weights associated with the independent variables? (Wilson and Carry, 1969, p. 81).

The test of homogeneity of means in analysis of variance is accomplished by comparing the variation among the sample means with that among the observations. The test of homogeneity of regression coefficients is based on the same principle, except that the comparison is between the variation among the sample regression coefficients and that among the observations (Li, 1964, Vol. 1, p. 393).

Procedures

The test of homogeneity of regressions estimates the residual sum of squares in two ways. First, the sum of squares is estimated by using the pooled regression weights; then the same sum of squares is estimated by using regression weights determined for each group separately. Let the former be SS_1 and the latter be SS_2 . The difference between the two sums of squares ($SS_1 - SS_2$) is obtained and used to test the significance of difference in regression by a likelihood ratio (Wilson and Carry, 1969). The ratio is given by:

$$\frac{(SS_1 - SS_2)(n - g - g.p)}{SS_2.(g - 1).p}$$

where n = the number of cases in all groups combined
 g = the number of groups being compared
 p = the number of predictor variables
 SS_1 = the residual sum of squares for the pooled regression weights
 SS_2 = the sum of the residual sums of squares determined for each group

When the null hypothesis that the regression weights in the populations are the same is true, this ratio has a sampling distribution which can be approximated by an F distribution with $(g - 1).p$ and $(n - g - g.p)$ degrees of freedom (Wilson and Carry, 1969, p. 84). It was this ratio that was employed to test the homogeneity of regressions of the two groups in this study.

The regression equation for group I with the cumulative GPA as the criterion was found to be:

$$Y = 2.42 + .10X_1 - .02X_2 + .13X_3 + .15X_4 + .09X_5.$$

The regression equation for group II with the cumulative GPA as the criterion was found to be:

$$Y = 2.58 + .12X_1 - .13X_2 + .19X_3 + .20X_4 + .13X_5.$$

The regression equation for group I with the test score GPA as the criterion was found to be:

$$Y = 2.20 + .30X_1 - .23X_2 + .26X_3 + .33X_4 + .30X_5.$$

The regression equation for group II with the test score GPA as the criterion was found to be:

$$Y = 2.43 + .31X_1 - .18X_2 + .28X_3 + .30X_4 + .28X_5.$$

Tables 4.9 and 4.10 give the regression coefficients and their standard errors.

Table 4.9. Regression Coefficients and Standard Errors with the Cumulative GPA as criterion.

Factors	Group I		Group II	
	Coefficients	Std. Errors	Coefficients	Std. Errors
Constant	2.42	0.035	2.58	0.023
1	0.10	0.025	0.12	0.024
2	-0.02	0.033	-0.13	0.020
3	0.13	0.027	0.19	0.022
4	0.15	0.026	0.20	0.021
5	0.09	0.028	0.13	0.021

Table 4.10. Regression Coefficients and Standard Errors
with the Test Score GPA as Criterion.

Factors	Group I		Group II	
	Coefficients	Std. Errors	Coefficients	Std. Errors
Constant	2.20	0.045	2.43	0.037
1	0.30	0.032	0.31	0.041
2	-0.23	0.042	-0.18	0.034
3	0.26	0.035	0.28	0.036
4	0.33	0.033	0.30	0.035
5	0.30	0.036	0.28	0.034

In order to test for homogeneity of regressions,
the hypotheses were formulated and tested for significance.

Hypothesis 3

The third hypothesis, the first of two relating to
homogeneity of regression, was:

The parameters of the regression equations for
predicting the cumulative GPA at the end of the
sophomore year from a set of factors derived from
aptitude variables are the same for blacks and
whites.

The test statistic employed was the likelihood
ratio given by

$$F = \frac{(SS_1 - SS_2)(n-g-g.p)}{SS_2.(g-1).p}$$

and table 4.11 provides the quantities needed for this
ratio.

Table 4.11. Analysis of Homogeneity of Regressions on The Cumulative GPA

Source	Sum of Squares	d.f.	F
Pooled Regression	79.314		
Total for two groups	51.173	723	
Difference in Regressions	28.141	5	79.517*

*Significant at less than .001 level of type I error.

The likelihood ratio was significant when the analysis was completed. Consequently the null hypothesis was rejected and the alternate hypothesis was accepted. It was concluded that the parameters of regressions for predicting the cumulative GPA from derived factors were different for blacks and whites.

Hypothesis 4

Hypothesis 4 was stated as follows:

The parameters of the regression equation for predicting the test score GPA from a set of factors derived from aptitude measures are the same for blacks and whites.

The test statistic was the likelihood ratio given by:

$$F = \frac{(SS_1 - SS_2)(n-g-g.p)}{SS_2 \cdot (g-1).p}$$

Table 4.12 provides the quantities needed for this ratio.

Table 4.12. Analysis of Homogeneity of Regressions on the Test Score GPA.

Source	Sum of Squares	d.f.	F
Pooled Regressions	130.844	-	-
Total for two groups	125.988	475	-
Difference in Regressions	4.856	5	3.677*

*Significant at the .01 level of type I error.

The likelihood ratio was significant when the analysis was completed. Consequently the null hypothesis was rejected and the alternate hypothesis was accepted. It was concluded that the parameters of regressions for predicting the test score GPA from derived factors were different for blacks and whites.

The reader will recall that one of the purposes of this study was to compare the regression functions for predicting college success of blacks and whites from aptitude variables. Two criteria were used as indicators of college success: the cumulative GPA at the end of the winter term 1970 and the test score GPA based on examinations alone in college basic courses. Results of the statistical tests revealed a significant difference between the regression functions of the two groups under both criteria. Further interpretation of these results will be provided in next chapter.

Variances Explained by Aptitude Variables

The test of homogeneity of regressions revealed a significant difference in the regression equations for predicting the cumulative GPA and the test score GPA for the two groups. This implies that the estimated (predicted) criterion values will be different for those in one group from those in the other group, even if the subjects in the two samples had equal scores on predictors. The goodness of the regression equations is determined by the proportion of variances accounted for while using the equations for prediction. The square of the multiple correlation coefficient, R^2 , otherwise known as the coefficient of multiple determination represents the proportion of variance accounted for by the predictors using a linear regression. In order to investigate whether the proportion of variance explained by the aptitude variables is the same in both groups, the two additional null hypotheses were generated and tested:

Hypothesis 5

Hypothesis five was as follows:

The proportion of variance in cumulative GPA that is predictable from the correlation with aptitude measures is the same for blacks and whites.

Overall Test - The test of this hypothesis involved the transformation of multiple R into Fisher Z. The reason for

this transformation was that the population ρ 's were not known. When the population $\rho = 0$, the sampling distribution of R may be regarded as approximately normal. However, when population is not zero, the distribution of the multiple R tends to be very skewed either to the left or to the right depending on population ρ being greater than or less than zero. R. A. Fisher (1942) has shown that the sampling distribution of a particular function of R is approximately normal for samples of moderate size, no matter what the population ρ is.

The function is given by:

$$Z = 1/2 \log_e (1 + R)/(1 - R))$$

Since the transformation is 'one to one,' inferences about Z are applicable to R .

A test of the hypothesis that the two populations show equal correlations is provided by the ratio:

$$\frac{Z_1 - Z_2}{s(Z_1 - Z_2)}$$

where Z_1 is the transformed value of the correlation coefficient for the first sample

Z_2 is the transformed value of the correlation coefficient for the second sample

$s(Z_1 - Z_2)$

$$\sqrt{1/(N_1 - 3) + 1/(N_2 - 3)}$$

For reasonably large samples, this ratio can be referred to the normal distribution.

In this study the multiple correlation for group I was .5119 and for group II it was .5292 when the cumulative GPA was used as the criterion. The Z values corresponding to those correlations were .5654 and .5901 respectively. The number of students in group I, N_1 , was 224 and the number in group II, N_2 , was 511. Thus

$$Z = \frac{(.5654 - .5901)}{\sqrt{1/221 + 1/508}} \\ = -1.547$$

The value of the test statistic Z was not significant at $\alpha = .05$. Consequently, the null hypothesis was not rejected. The data, it was concluded, did not provide evidence for a significant difference in the proportion of variance accounted for by the predictors in both groups.

Partitioning Procedure. The multiple R^2 measured the proportion of variance in the criterion explained by the five predictor factors simultaneously. The contribution of each factor was determined by partitioning R^2 into r_1^2 , r_2^2 , r_3^2 , r_4^2 and r_5^2 , where r_i is the simple correlation of ith factor with the criterion. In the case of ~~non~~-intercorrelated factors the sum of the squares of the individual correlations add up to the multiple R^2 . Each r^2 reflects the contribution attributable to each factor.

Table 4.13 provides the simple correlations of the factors with the cumulative GPA, the squares of the correlations, the values of the corresponding Fisher Z's and the values of Z-statistic for the two groups.

Table 4.13. Correlations, Squares of Correlations, Values of Fisher Z's and of Z-statistic.

Factor	Correlation(r)		r^2		Fisher Z		Z-statistic	
	Gp.I	Gp.II	Gp.I	Gp.II	Gp.I	Gp.II	Gp.I	Gp.II
1	.21	.05	.0441	.0025	.2132	.0500	3.168*	1.127
2	.05	.18	.0025	.0324	.0500	.1820	.743	4.102*
3	.27	.28	.0729	.0784	.2769	.2877	4.115*	6.485*
4	.31	.31	.0961	.0961	.3205	.3205	4.763*	7.224*
5	.19	.19	.0361	.0361	.1923	.1923	2.858*	4.334*

*Significant at or less than .01 level of type I error.

The statistical tests showed that in group I the correlations of factors 1,3,4 and 5 with the cumulative GPA were significantly different from zero, whereas the correlation of factor 2 was not significant. Factor 4 explained approximately ten percent, factor 3 approximately seven percent, factor 1 approximately one percent and factor 5 approximately four percent of the criterion variance.

In group II the correlations of factors 2,3,4 and 5 with the cumulative GPA were significant, whereas the correlation of factor 1 was not significant. Just as in group I factor 4 explained approximately ten percent of the criterion variance. Factors 3,5 and 2 explained eight percent, four percent and three percent of the variance respectively.

The fact that factor 2 in group I and factor 1 in group II were not significant suggested the differential contribution of these two factors in predicting the cumulative GPA. The reader will recall that factor 1 had the highest loading on CQT-Verbal and factor 2 had the highest loading on CQT-Numerical. This would suggest that CQT-Verbal and CQT-Numerical had differential contribution in prediction for blacks and whites. CQT-Verbal appears more important in the case of blacks and CQT-Numerical appears more important in the case of whites.

A test of significance performed on the difference in correlations for the two groups on factors 1 and 2 using the ratio suggested by Hays (1963, p. 532) showed a significance level of $\alpha=.05$ on factor 1 and a significance level of $\alpha=.10$ on factor 2.

Hypothesis 6

The sixth hypothesis was like the fifth except the test score GPA was the criterion instead of the cumulative GPA:

The proportion of variance in the test score GPA that is predictable from the correlation with the aptitude variables is the same for blacks and whites.

Overall Test. The test statistic employed was the ratio:

$$\frac{Z_1 - Z_2}{s(Z_1 - Z_2)}$$

where Z_1 is the Fisher Z for the multiple correlation in the first group
 Z_2 is the Fisher Z for the multiple correlation in the second group
 $s(Z_1 - Z_2)$ is the standard error of estimate of the difference in correlations.

The multiple correlation for group I was .7688 and for group II it was .6551, when the test score GPA was used as the criterion. The Z values corresponding to those correlations were 1.015 and .7823 respectively.

N_1 was 216 and N_2 was 268. Thus

$$z = (1.015 - .7823) / \sqrt{1/213 + 1/265}$$

$$= 2.562$$

The value of the test statistic Z was significant at $\alpha = .01$. Consequently, the null hypothesis was rejected and it was concluded that the proportion of variance accounted for by aptitude variables is not the same for blacks and whites when the test score GPA is used as the criterion. The linear regression predicted the test score GPA with greater accuracy in the case of blacks than in the case of whites.

Partitioning Procedure. In order to determine the contribution of each factor the multiple R^2 was partitioned into r_1^2 , r_2^2 , r_3^2 , r_4^2 and r_5^2 , where r_i is the simple correlation of i th factor with the test score GPA. Table 4.14 provides the simple correlations of the factors with the test score GPA, the squares of those correlations, the values of the corresponding Fisher Z's and of Z-statistic.

Table 4.14. Correlations, Squares of Correlations, Values of Fisher Z's and of Z-statistic.

Factor	Correlation(r)		r^2		Fisher Z		Z-statistic	
	Gp.I	Gp.II	Gp.I	Gp.II	Gp.I	Gp.II	Gp.I	Gp.II
1	.40	.17	.1600	.0289	.4236	.1717	6.168*	2.800*
2	-.14	-.15	.0196	.0225	-.1409	-.1511	2.052**	2.464**
3	.30	.32	.0900	.1024	.3095	.3316	4.506*	5.408*
4	.41	.34	.1681	.1156	.4356	.3541	6.342*	5.775*
5	.36	.35	.1296	.1225	.3769	.3654	5.488*	5.960*

**Significant at .05 level of type I error

*Significant at .01 level of type I error

The statistical tests showed that in both groups the correlations of all factors were significantly different from zero. In group I factors 1 to 5 explained approximately sixteen percent, three percent, nine percent, seventeen percent and thirteen percent respectively. In group II factors 1 to 5 explained approximately three percent, two percent, ten percent, twelve percent and twelve percent respectively.

Just as in the case of the cumulative GPA, the difference in the correlations of factor 1 for the two groups was marked. In group I the correlation was .47, whereas in group II the correlation was only .17. Factor 1, the reader will recall, had the highest loading on CQT-Verbal. CQT-Verbal appears more important in predicting the test score GPA in the case of blacks than in the case of whites.

A test of significance performed on the difference in the correlations for the two groups on factor 1 showed a significance level of less than $\alpha = .01$.

Examination of Curvilinear Relationship

The test of linearity performed on the regression of predictor variables on the cumulative GPA and the test score GPA in both groups showed that the use of linear model on prediction explained a significant amount of the criterion variances. In order to explore the possibility of improving the accuracy of prediction by addition of non-linear terms in regression (polynomial in higher degree), each of the criterion variables was plotted against each of the predictors for each group. The following figures present the scatter diagrams associated with each of the predictor variables and each of the criteria.

Examination of figures 3.1 to 3.11 depicting the scatter diagrams to represent the relationship between the predictor variables and the cumulative GPA showed that a linear regression appeared the best fit for the data. The use of higher degree polynomials for regression equations would hardly increase the amount of explained variance in the criterion of cumulative GPA. The same trend was noticed in the scatter diagrams, not reported here, representing the relationship between the predictor variables and the test score GPA.

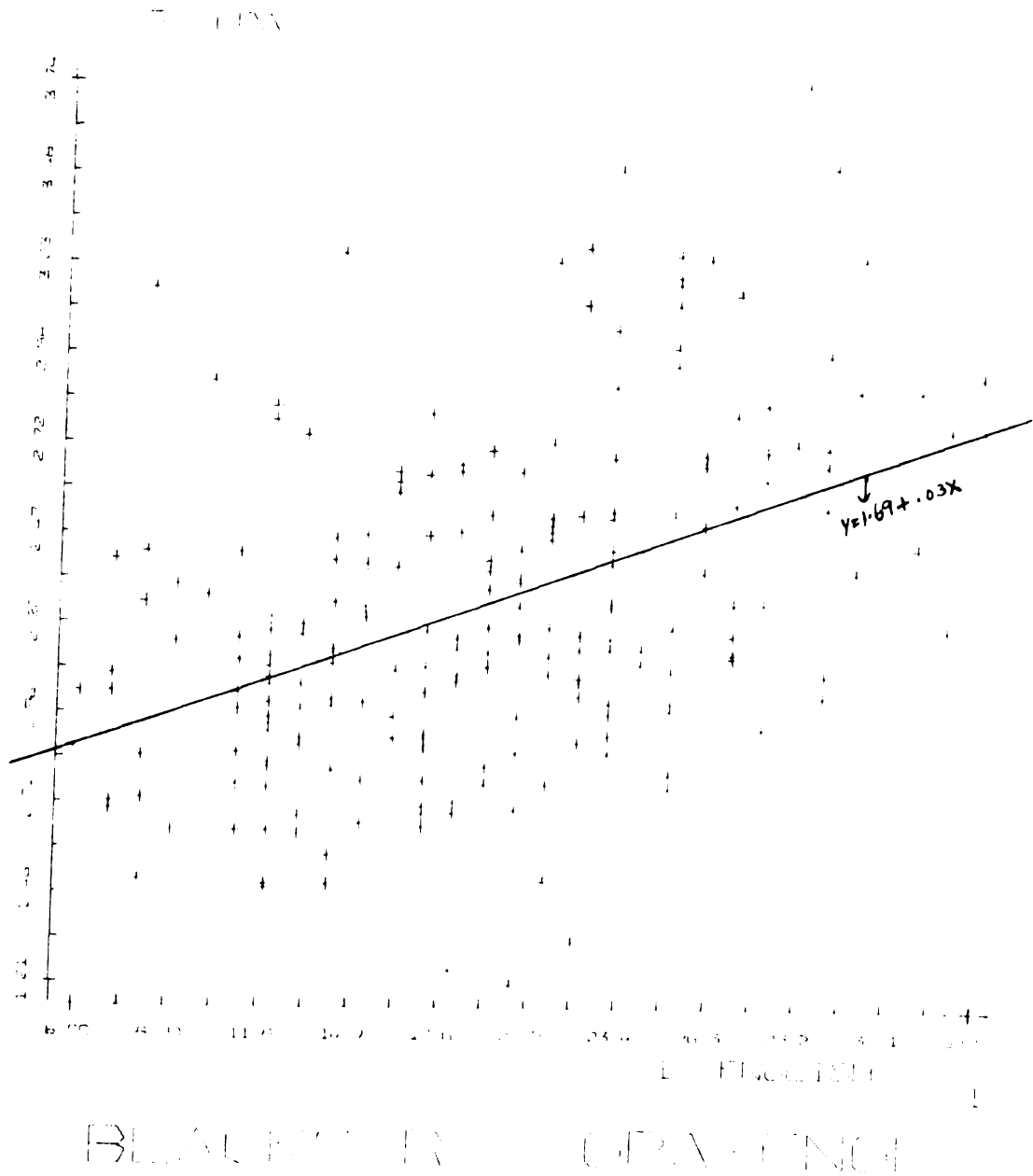
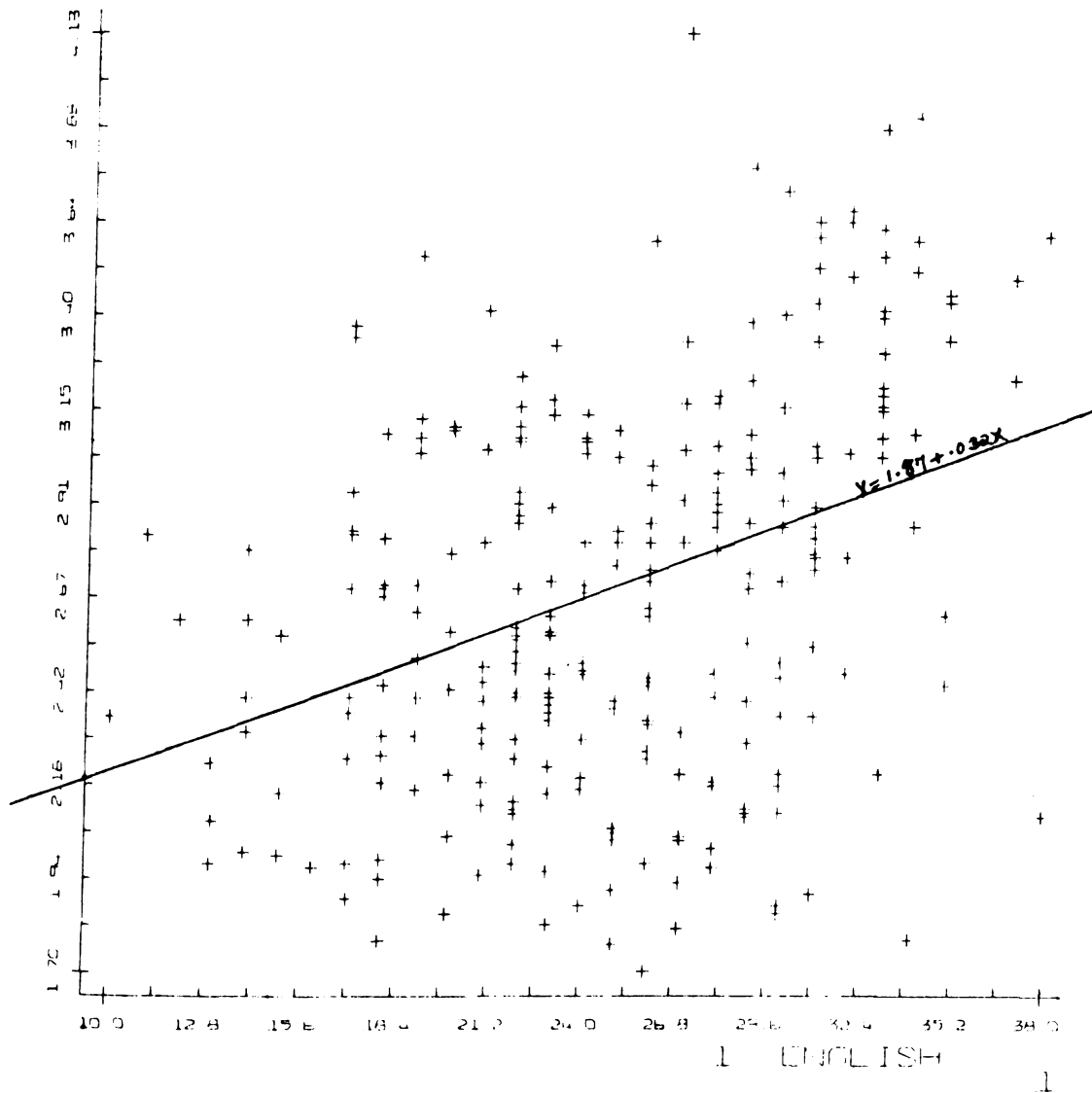


Figure 4.1. Scatter Diagram and Regression of the Cumulative GPA on MSU English for Blacks

7 GPA



WHITES R

GPA-ENGL

Figure 4.2. Scatter Diagram and Regression of the Cumulative GPA on MSU English for Whites

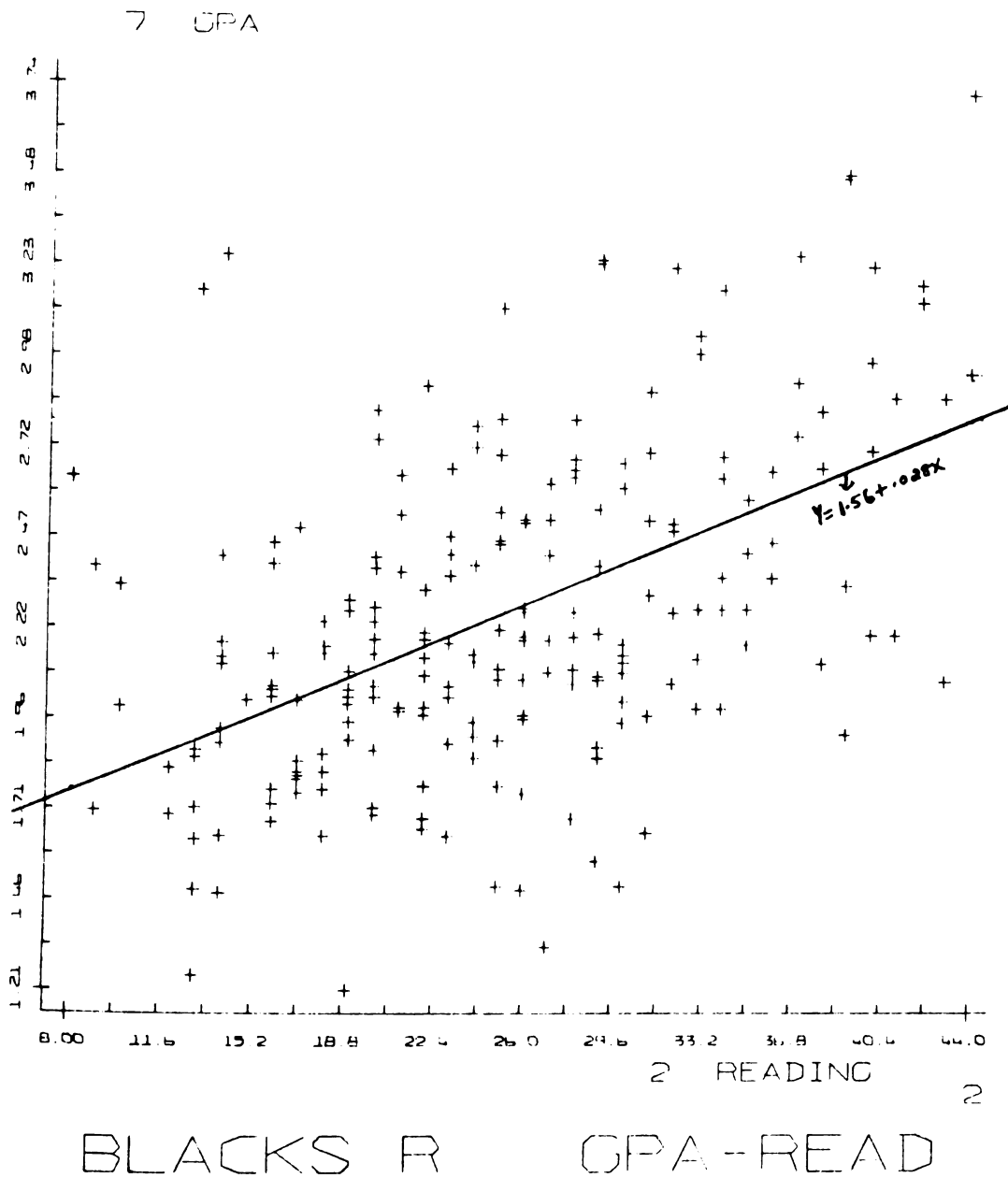


Figure 4.3. Scatter Diagram and Regression of the Cumulative GPA on MSU Reading for Blacks

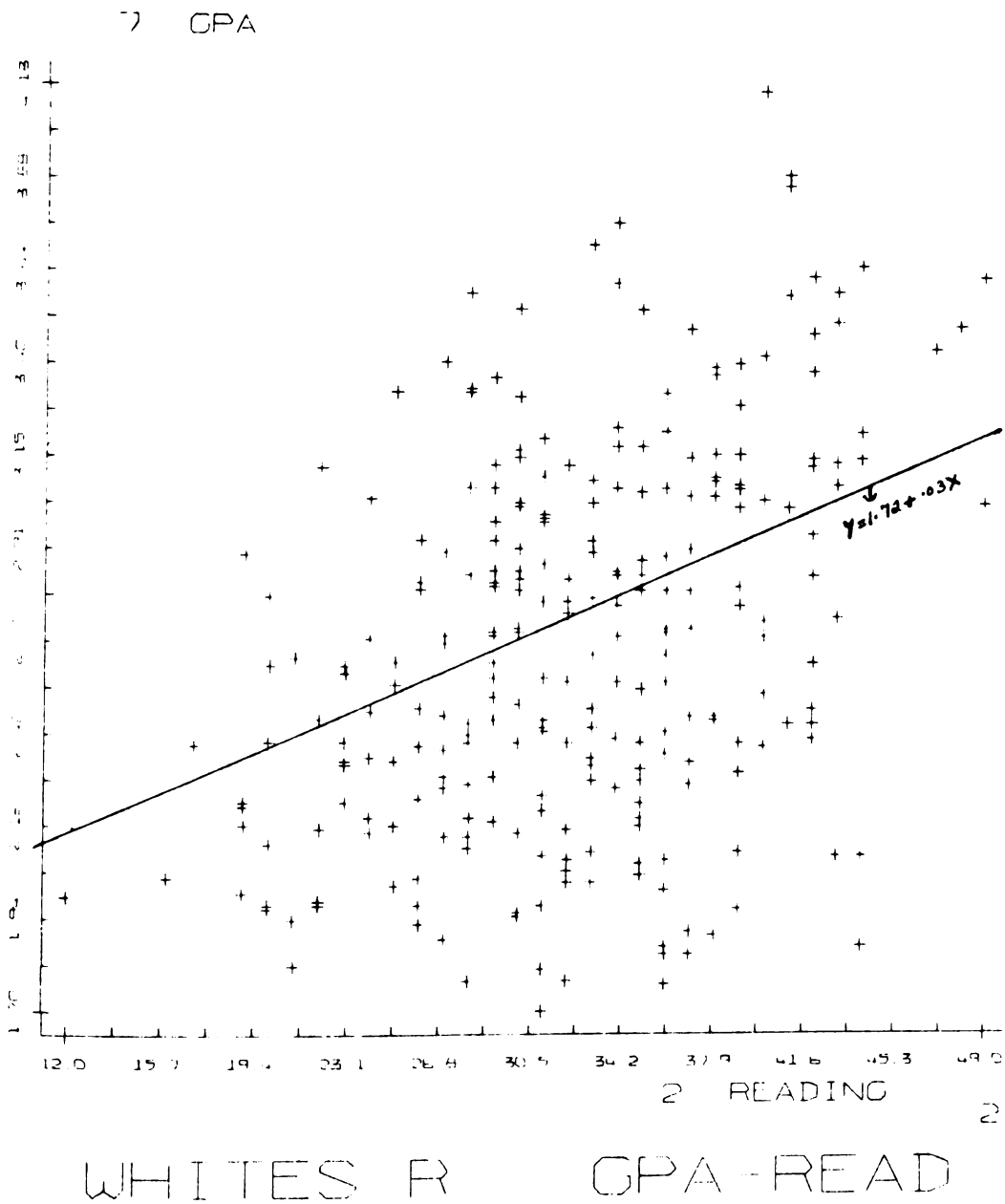


Figure 4.4. Scatter Diagram and Regression of the Cumulative GPA on MSU Reading for Whites

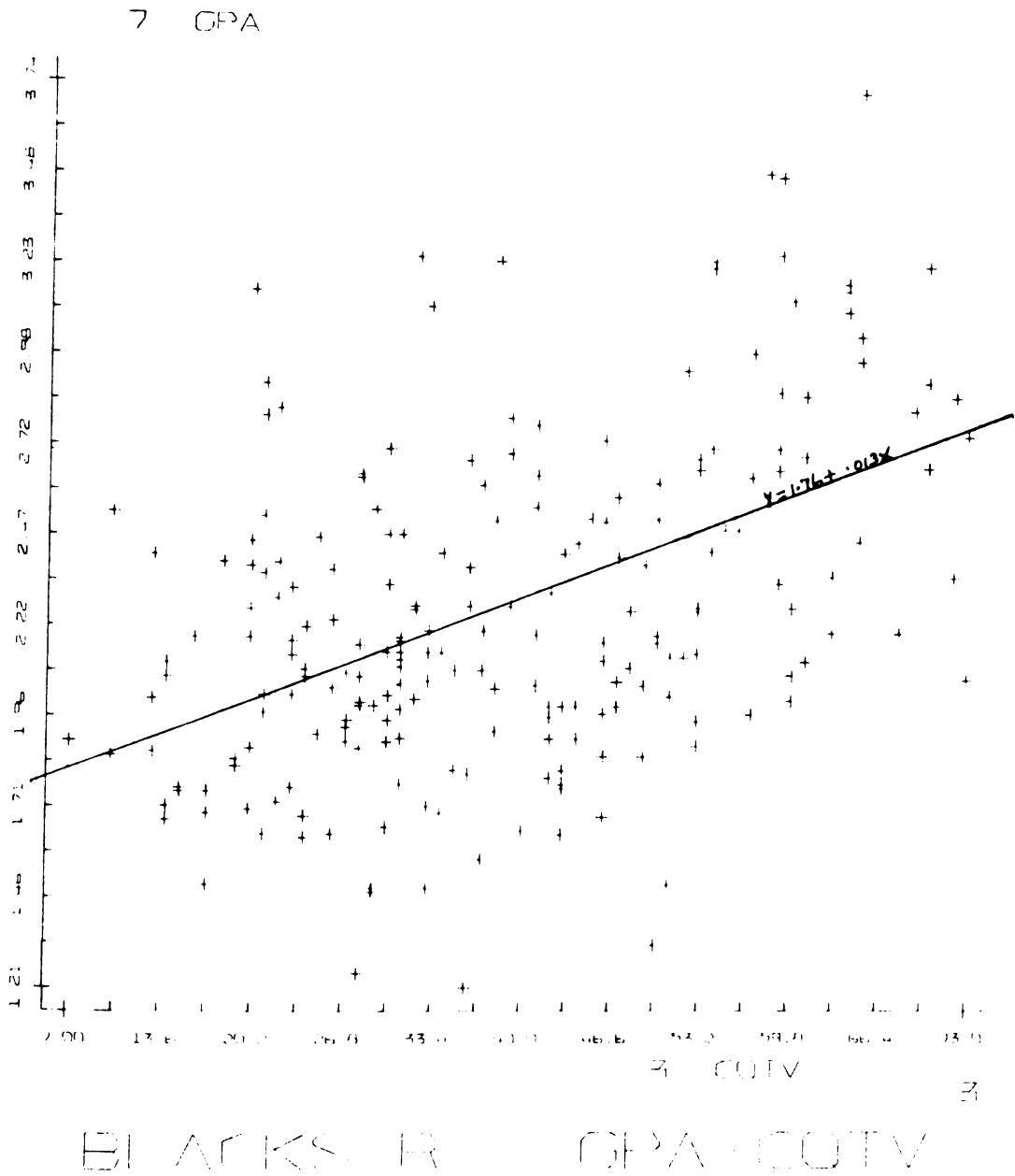


Figure 4.5. Scatter Diagram and Regression of the Cumulative GPA on CQT-Verbal for Blacks

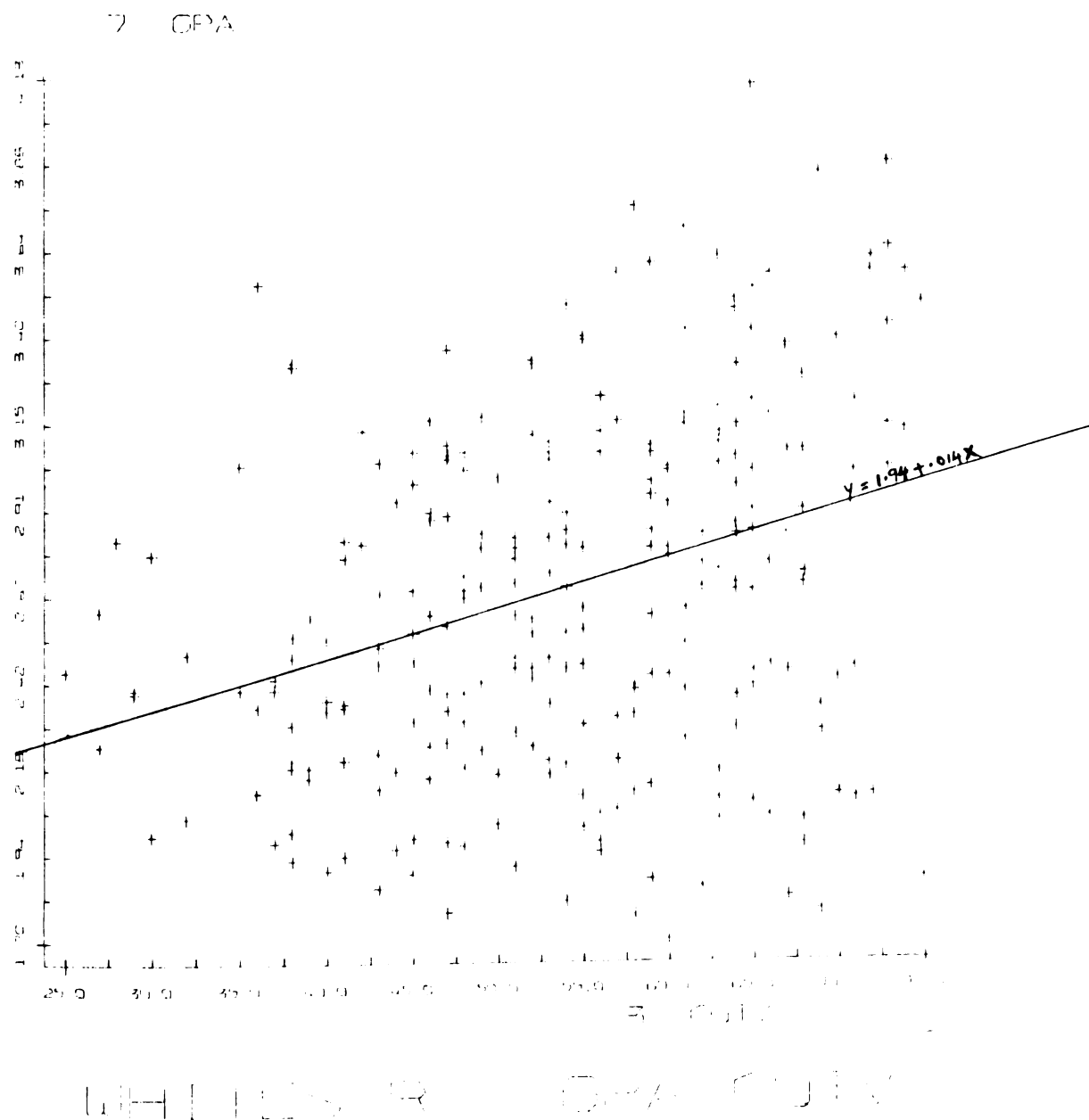


Figure 4.6. Scatter Diagram and Regression of the Cumulative GPA on CQT-Verbal for Whites

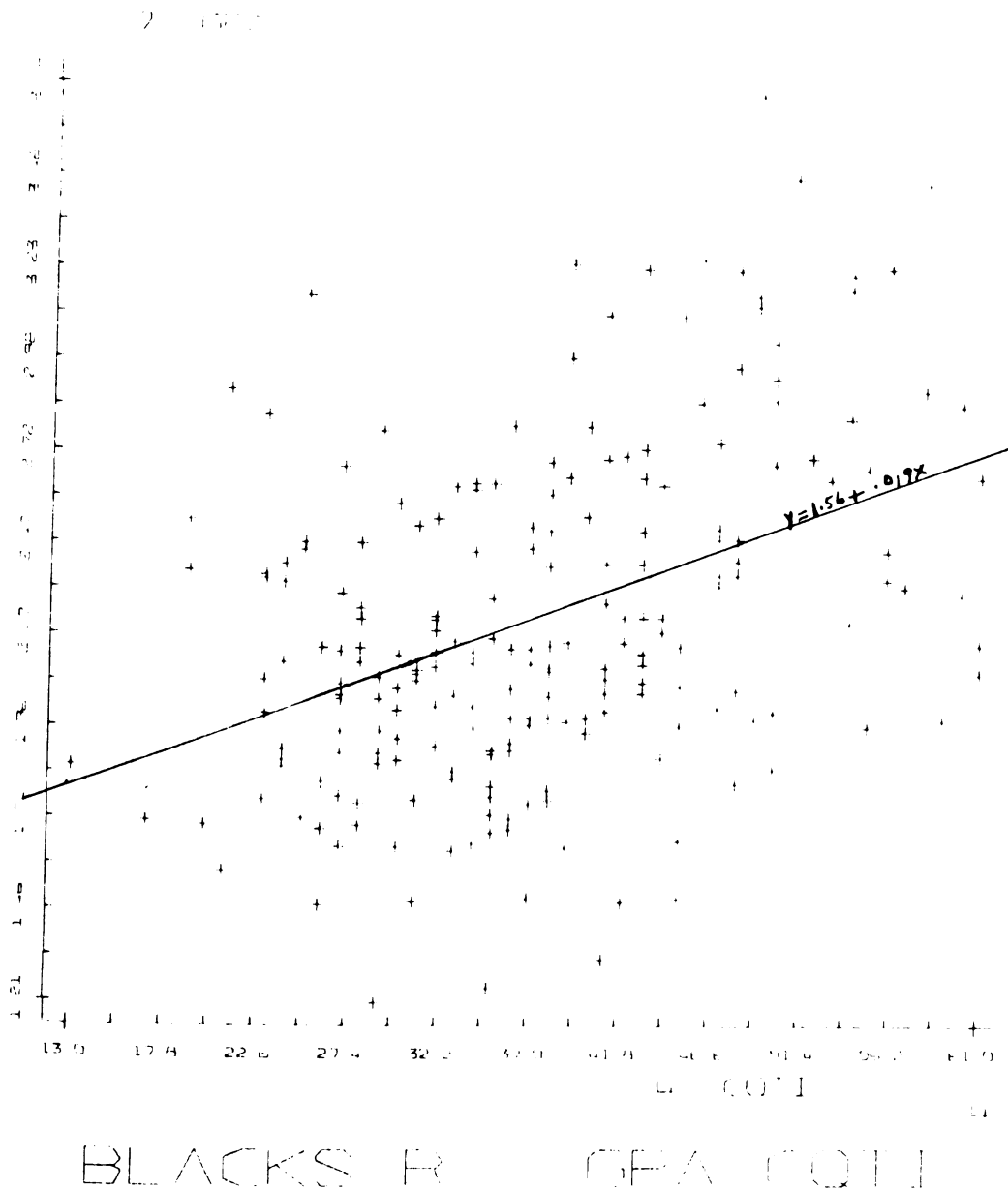


Figure 4.7. Scatter Diagram and Regression of the Cumulative GPA on CQT-Informational for Blacks

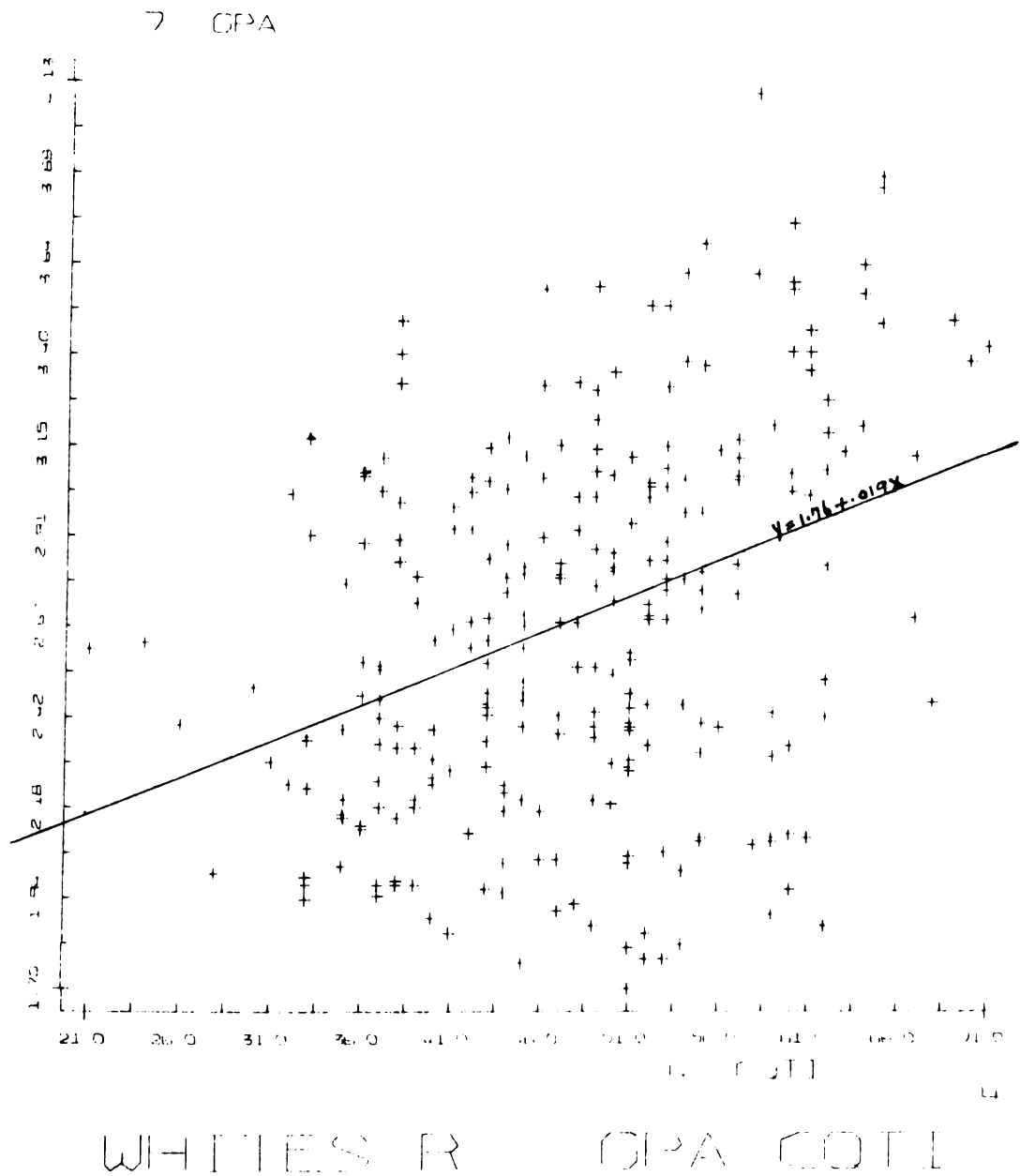


Figure 4.8. Scatter Diagram and Regression of the Cumulative GPA on CQT-Informational for Whites

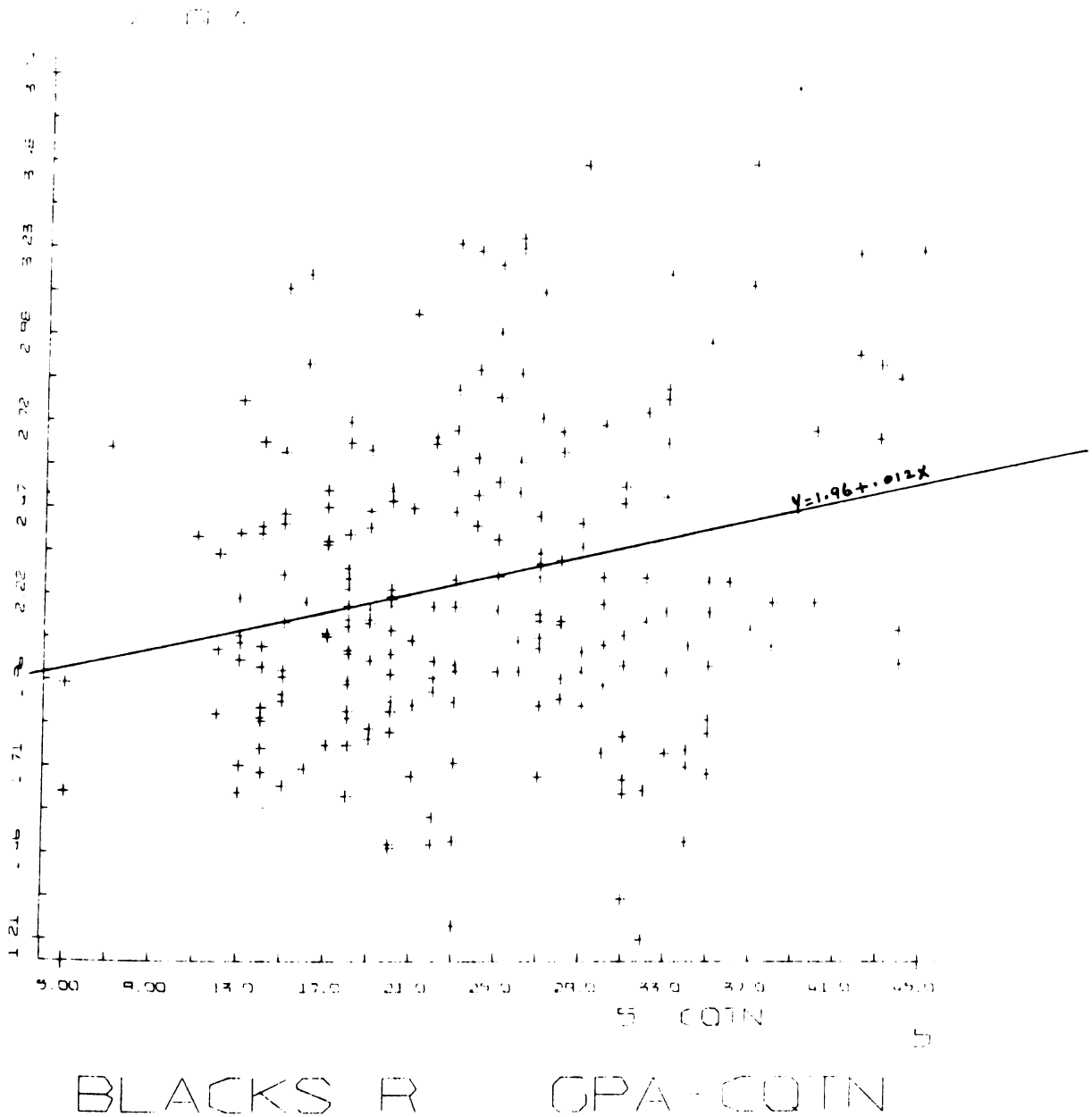


Figure 4.9. Scatter Diagram and Regression of the Cumulative GPA on CQT-Numerical for Blacks

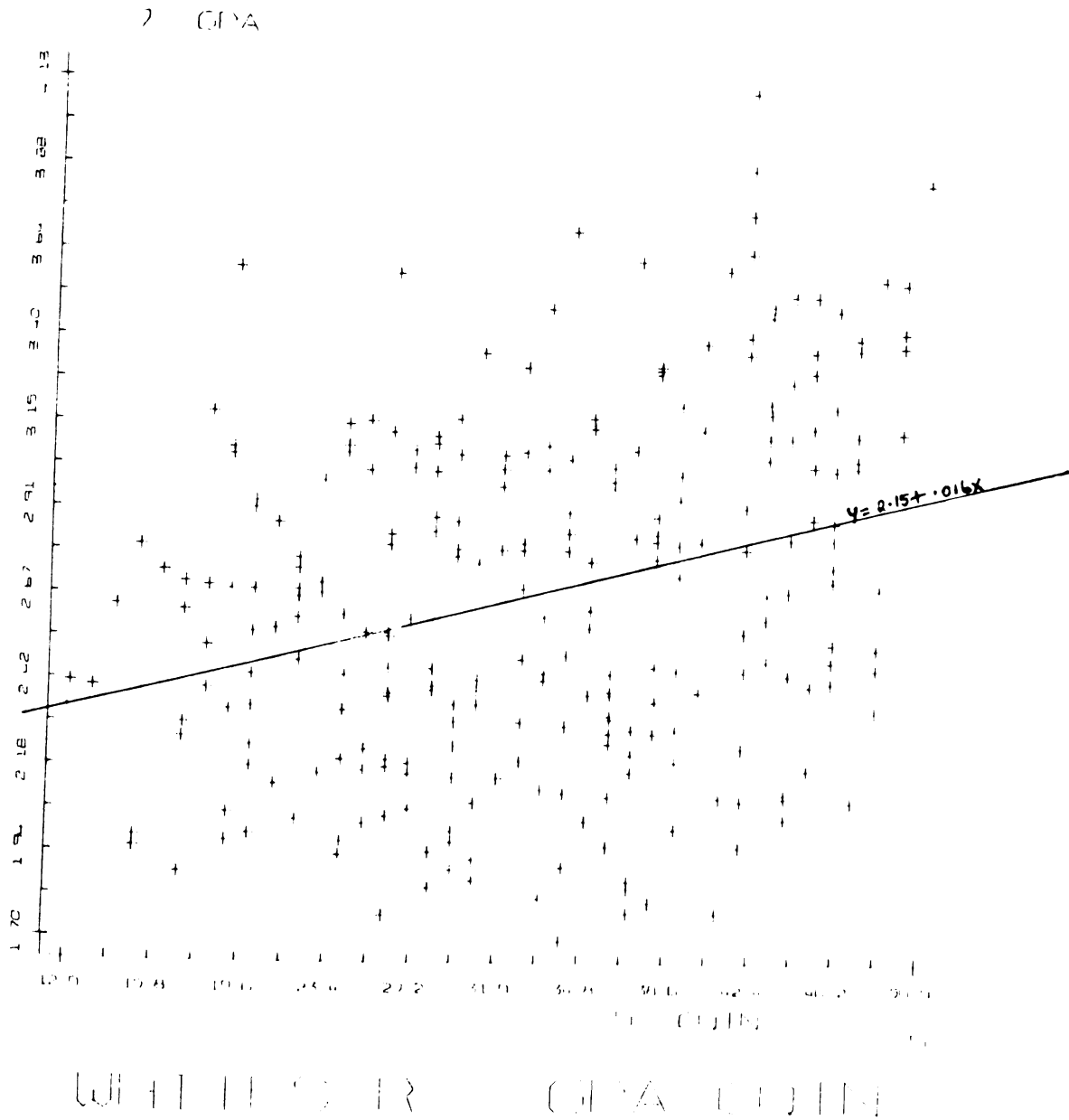


Figure 4.10. Scatter Diagram and Regression of the Cumulative GPA on CQT-Numerical for Whites

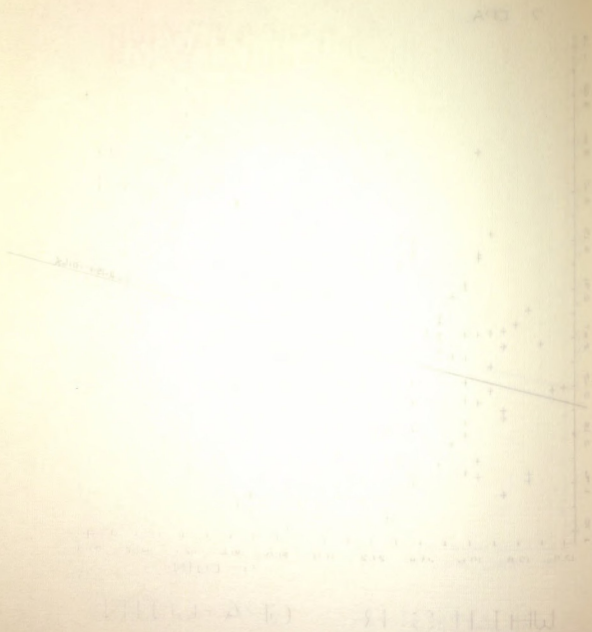


Figure 4.10. Scatter Diagram and Regression of the Cumulative GPA on CGT-homework for White

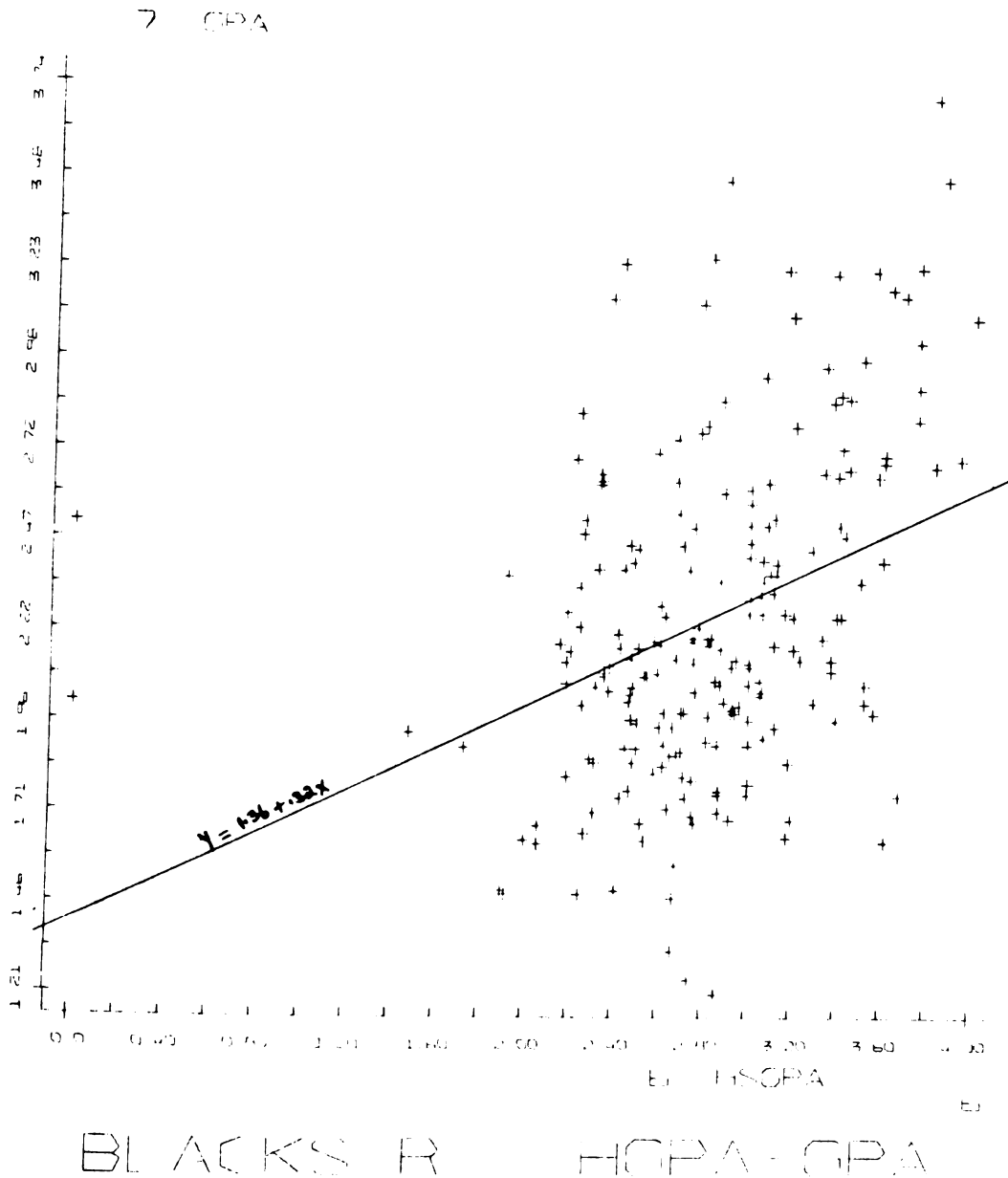


Figure 4.11. Scatter Diagram and Regression of the Cumulative GPA on High School GPA for Blacks

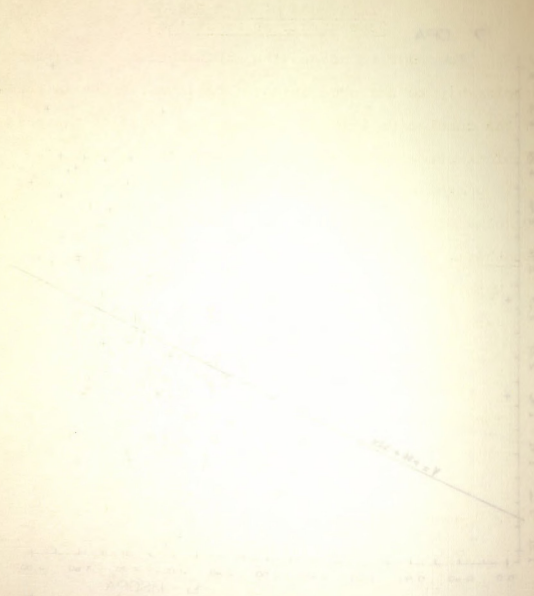


Figure 4.11. Scatter Diagram and Regression of the
Cumulative GPA on High School GPA
for Blacks

Influence of High School
Scholarship on Prediction

In order to assess the contribution of high school scholarship to the prediction of college success in terms of the cumulative GPA and the test score GPA in the case of black students attending an integrated college, two null hypotheses were tested using a Variance Ratio Test (Baggley, 1962, p. 21).

Hypothesis 7

Hypothesis 7, the first tested for present purposes, was:

The accuracy of prediction of the cumulative GPA for blacks is not enhanced by adding the high school GPA to the set of aptitude predictors.

The test statistic was:

$$F = \frac{(R_+^2 - R^2)(N-m-2)}{1 - R_+^2}$$

where R = the multiple correlation involving only the aptitude predictors,
 R_+ = the multiple correlation involving the aptitude predictors and the high school GPA,
 N = the number of subjects,
 m = the number of predictors.

The multiple correlation involving only the aptitude predictors was .5226 and that involving the aptitude predictors and high school GPA was .5749, when the cumulative GPA was used as the criterion. The number of aptitude predictors was 5, and the N was 216. Thus

Influence of High School
Scholarship on Prediction

In order to assess the contribution of high school scholarship to the prediction of college success in terms of the cumulative GPA and the test score GPA in the case of black students attending an integrated college, two null hypotheses were tested using a Variance Ratio Test (Sagley, 1962, p. 21)

Hypothesis 7

Hypothesis 7, was first tested for present purposes,

was:

The accuracy of prediction of the cumulative GPA for blacks is not enhanced by adding the high school GPA to the high aptitude predictors.

The test statistic was

$$F = \frac{(R_+^2 - R^2) / (N - m - 1)}{R^2 / (N - m - 1)}$$

where R = the multiple correlation involving only the aptitude predictors,
 R_+ = the multiple correlation involving the aptitude predictors and the high school GPA,
 N = the number of subjects,
 m = the number of predictors.

The multiple correlation involving only the aptitude predictors was .5236 and that involving the aptitude predictors and high school GPA was .5749, when the cumulative GPA was used as the criterion. The number of aptitude predictors was 5, and the N was 216. Thus

$$\begin{aligned}
 F &= \frac{(.5749^2 - .5226^2)(216 - 5 - 2)}{1 - .5726^2} \\
 &= \frac{.0514 \times 209}{.6695} \\
 &= 17.918
 \end{aligned}$$

The value of the test statistic F was significant at a = .01 level. Consequently the null hypothesis was rejected and it was concluded that the accuracy of prediction of the cumulative GPA for blacks was enhanced by adding the high school GPA to the set of aptitude predictors. The aptitude variables alone explained approximately twenty seven percent of the criterion variance, whereas the aptitude variables with the high school GPA explained approximately thirty four percent. The estimated improvement in terms of explained variance is six percent.

Hypothesis 8

Hypothesis 8 was:

The accuracy of prediction of the test score GPA for blacks is not enhanced by adding the high school GPA to the set of aptitude predictors.

The test statistic was the Variance Ratio:

$$F = \frac{(R_+^2 - R^2)(N-m-2)}{1 - R_+^2}$$

The multiple correlation involving only the aptitude predictors was .7688 and that involving the aptitude predictors and high school GPA was .8068. The number of aptitude predictors was 5, and N was 216. Thus

$$F = \frac{(.5749^2 - .5228^2) / (216 - 2 - 2)}{1 - .5749^2}$$

$$= \frac{.0514 \times 209}{.6695}$$

$$= 17.918$$

The value of the test statistic F was significant

at a .01 level. Consequently the null hypothesis was rejected and it was concluded that the accuracy of prediction of the cumulative GPA for blacks was enhanced by adding the high school GPA to the set of aptitude predictors. The aptitude GPA alone explained approximately twenty seven percent of the variance, whereas the aptitude variable with low school GPA explained approximately thirty three percent. The estimated improvement in terms of explained variance is six percent.

Hypothesis 8

Hypothesis 8 was

The accuracy of prediction of the test score GPA for blacks is not enhanced by adding the high school GPA to the set of aptitude predictors.

The test statistic was the Variance Ratio:

$$F = \frac{(R_1^2 - R_2^2) / (N - m - 2)}{1 - R_1^2}$$

The multiple correlation involving only the aptitude predictors was .7588 and that involving the aptitude predictors and high school GPA was .8068. The number of aptitude predictors was 5, and N was 216. Thus

$$F = \frac{.0598 \times 209}{.3491}$$

$$= 35.801$$

The value of the test statistic F was significant at $\alpha=.01$ level. Consequently the null hypothesis was rejected and it was concluded that the accuracy of prediction of the test score GPA for blacks was enhanced by adding the high school GPA to the set of aptitude predictors.

The aptitude variables alone explained fifty nine percent of the variance in the test score GPA, whereas sixty five percent was explained when the high school GPA was added. Thus the estimated improvement brought about by the addition of high school GPA was six percent. The same point estimate of the improvement was observed in the case of the cumulative GPA.

Thus the college achievement, measured in terms of the cumulative GPA or the test score GPA, was better predicted by adding the high school GPA to aptitude variables in the case of black students.

Moderator Variables in Prediction

The moderator variables employed in the study were sex, home background, curricular preference, and intra-individual variability in scores on the tests in the aptitude test battery. In order to determine the effectiveness

$$F = \frac{.0298 \times 209}{.3491} = 35.801$$

The value of the test statistic F was significant at $\alpha=.01$ level. Consequently the null hypothesis was rejected and it was concluded that the accuracy of prediction of the test score GPA for blacks was enhanced by adding the high school GPA to the set of aptitude predictors.

The aptitude variables alone explained fifty nine percent of the variance in the test score GPA, whereas sixty five percent was explained when the high school GPA was added. Thus the predicted improvement brought about by the addition of high school GPA was six percent. The same point estimate of the improvement was observed in the case of the cumulative GPA. Thus the college achievement, measured in terms of the cumulative GPA or the test score GPA, was better predicted by adding the high school GPA to aptitude variables in the case of black students.

Moderator Variables in Prediction

The moderator variables employed in the study were sex, home background, curricular preference, and intra-individual variability in scores on the tests in the aptitude test battery. In order to determine the effectiveness

of these moderator variables in predicting college success defined in terms of the cumulative GPA and the test score GPA, several additional hypotheses were formulated and tested for significance by the ratio (Hays, 1963, p. 532):

$$\frac{Z_1 - Z_2}{\sigma(Z_1 - Z_2)}$$

where Z_1 represents the value of the Fisher Z transformation of the multiple correlation coefficient for the first sample,
 Z_2 represents the transformed value for the second sample, and

$$\sigma(Z_1 - Z_2) = \sqrt{1/(N_1 - 3) + 1/(N_2 - 3)}.$$

This section describes the results of these tests.

Sex and Predictability

Hypothesis 9

The hypothesis of the effect of using sex as a moderator variable with cumulative GPA as the criterion was:

When the cumulative GPA is the criterion, the prediction is equally accurate for males and females in the black population.

The multiple correlations for males and females were .4490 and .6614 respectively. The corresponding Z values were .4833 and .7592. There were 87 males and 129 females in the group. Thus the test statistic ratio was:

$$Z = \frac{.2759 \times 102.86}{14.49} = 1.959$$

The value of the test statistic was significant at $\alpha = .05$ level. Consequently the null hypothesis of equality of correlations for males and females was rejected. It

of these moderator variables in predicting college success defined in terms of the cumulative GPA and the test score GPA, several additional hypotheses were formulated and tested for significance by the t-test (Hays, 1963, p. 232):

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{s^2}{n_1} + \frac{s^2}{n_2}}}$$

where $\bar{X}_1$ represents the value of the Fisher Z transform of the multiple correlation coefficient for the first sample, $\bar{X}_2$ represents the transformed value for the second sample, and

$$s^2 = \frac{1}{n_1 + n_2 - 2} \left[(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2 \right]$$

This section describes the results of these tests.

Sex and Predictability

Hypothesis 2

The hypothesis of the effect of using sex as a moderator variable with cumulative GPA as the criterion was:

When the cumulative GPA is the criterion, the prediction is equally accurate for males and females in the black population.

The multiple correlations for males and females were .4490 and .6614 respectively. The corresponding Z values were .4833 and .7592. There were 87 males and 129 females in the group. Thus the test statistic ratio was:

$$Z = \frac{.7592 \times 102.86}{14.48} = 1.829$$

The value of the test statistic was significant at .05 level. Consequently the null hypothesis of equality of correlations for males and females was rejected. It

was concluded that females are better predicted than males when the cumulative GPA is the criterion.

The percentage of criterion variance that was explained by the predictors for male group was twenty, whereas for females it was approximately forty four. Thus there was a twenty four percent improvement in the accuracy of prediction for females over that for males.

Hypothesis 10

The hypothesis of the effect of using sex as a moderator variable with test score GPA as the criterion was:

When the test score GPA is the criterion, the prediction is equally accurate for males and females in the black population.

The multiple correlation coefficients for males and females were .7713 and .8345 respectively. The corresponding Z values were 1.021 and 1.238. There were 87 males and 129 females in the group. Thus the test statistic ratio was:

$$Z = \frac{.217 \times 102.86}{14.49} = 1.54$$

The value of the test statistic was not significant at $\alpha = .05$ level. Consequently the null hypothesis of equality of correlations for males and females was not rejected. The data, it was concluded, did not provide evidence for the effectiveness of sex as moderator variable when the test score GPA was the criterion. This sex was effective as a moderator variable only when cumulative GPA was the criterion.

was concluded that females are better predicted than males when the cumulative GPA is the criterion. The percentage of criterion variance that was explained by the predictors for male group was twenty, whereas for females it was approximately forty four. Thus there was a twenty four percent improvement in the accuracy of prediction for females over that for males.

Hypothesis 10

The hypothesis of the effect of using sex as a moderator variable with test score GPA as the criterion was: When the test score GPA is the criterion, the prediction is equally accurate for males and females in the same population. The multiple correlation coefficients for males and females were .7713 and .8142 respectively. The corresponding F values were 1.051 and 1.458. There were 87 males and 132 females in the group. Thus the test statistic ratio was:

$$F = \frac{.217 \times 102.88}{14.42} = 1.54$$

The value of the test statistic was not significant at a .05 level. Consequently the null hypothesis of equality of correlations for males and females was not rejected. The data, it was concluded, did not provide evidence for the effectiveness of sex as moderator variable when the test score GPA was the criterion. This sex was effective as a moderator variable only when cumulative GPA was the criterion.

Home Background and Predictability

Hypothesis 11

Again two hypotheses were tested with the first using cumulative GPA:

When the cumulative GPA is the criterion, the prediction is equally accurate for students of suburban origins as those of urban or rural origins in the black population.

The multiple correlation coefficients for students of suburban origins and those of urban origins were .6493 and .5696 respectively. The corresponding Z values were .7751 and .6472. There were 153 in the urban and rural group, and 41 in the suburban group. Thus the test statistic was:

$$Z = \frac{.1279 \times 75.50}{13.71} = .704$$

The value of the test statistic was not significant at $\alpha = .05$ level. Consequently the null hypothesis of equality of correlations for these two groups was not rejected. The data, it was concluded, did not provide evidence for the effectiveness of home background as moderator variable when the cumulative GPA was the criterion.

Hypothesis 12

The second hypothesis concerning home background was:

When the test score GPA is the criterion, the prediction is equally accurate for students of suburban origins as those of urban or rural origins in the black population.

Home Background and Predictability

Hypothesis 11

Again two hypotheses were tested with the first using

Cumulative GPA:

When the cumulative GPA is the criterion, the prediction is equally accurate for students of suburban origins as those of urban or rural origins in the black population.

The multiple correlation coefficients for students of suburban origins and those of urban origins were .6493 and .5696 respectively. The corresponding F values were .7751 and .6473. Their joint F is for urban and rural group, and 41 in the suburban group. Thus the test statistic was:

$$F = \frac{.1178 \times 2}{.704} = .337$$

The value of the test statistic was not significant at a .05 level. Consequently the null hypothesis of equality of correlations for these two groups was not rejected. The data, it was concluded, did not provide evidence for the effectiveness of home background as moderator variable when the cumulative GPA was the criterion.

Hypothesis 12

The second hypothesis concerning home background was:

When the test score GPA is the criterion, the prediction is equally accurate for students of suburban origins as those of urban or rural origins in the black population.

The multiple correlation coefficients for students of suburban origins and those of urban or rural origins were .8855 and .7972 respectively. The corresponding Z values were 1.399 and 1.089. There were 41 in the suburban group and 153 in the urban or rural group. Thus the test statistic was:

$$Z = \frac{.310 \times 75.50}{13.71} = 1.707$$

The value of the test statistic was not significant at $\alpha=.05$ level. Consequently for test score GPA as for cumulative GPA, the null hypothesis of equality of correlations for these two groups was not rejected. Again it was concluded that the data did not provide evidence for the effectiveness of home background as moderator variable when the test score GPA was the criterion.

Curricular Preference and Predictability

There were only 18 students who preferred Social Science Curriculum. 121 Students preferred Physical or Natural Science Curriculum. The rest did not have any preference at all. Since the number in Social Science Category was too small, the intended analysis for the effectiveness of curricular preference as the moderator variable was not performed.

The multiple correlation coefficients for students

of suburban origins and those of urban or rural origins were .8855 and .7972 respectively. The corresponding F values were 1.399 and 1.089. There were 41 in the suburban group and 123 in the urban or rural group. Thus the test statistic was:

$$F = \frac{.310 \times 75.50}{12.71} = 1.707$$

The value of the test statistic was not significant at $\alpha = .05$ level. The hypothesis of equality of correlations for these two groups was not rejected. Again it was concluded that the test did not provide evidence for the effectiveness of home background as moderator variable when the test score GPA was the criterion.

Curricular Preference and Predictability

There were only 18 students who preferred Social Science Curriculum. 121 students preferred Physical or Natural Science Curriculum. The test did not have any preference at all. Since the number in Social Science Category was too small, the intended analysis for the effectiveness of curricular preference as the moderator variable was not performed.

Intra-individual variability and Predictability

Hypothesis 13

The hypothesis relating intra-individual variability to the prediction of cumulative GPA was:

When the cumulative GPA is the criterion, the prediction is equally accurate for those in the black population with low intra-individual variability in the sub-tests of the aptitude test battery as those with high variability.

The multiple correlation coefficients for the low variability and high variability groups were .5734 and .3517 respectively. The corresponding Z values were .6530 and .3270. There were 101 students in the low variability group and 115 in the high variability group. Thus, the test statistic was:

$$Z = \frac{.3260 \times 104.57}{14.49} = 2.353$$

The value of the test statistic was significant at $\alpha = .05$ level. Consequently the null hypothesis of equal prediction accuracy for these two groups was rejected. It was concluded that students with low intra-individual variability in the sub-test scores of aptitude test battery were better predicted than those with high variability when the cumulative GPA is the criterion.

The variance that was explained by the predictors in the low variability group was thirty three percent, whereas the variance explained in high variability group was twelve percent. The estimate of increase in accuracy

Inter-individual Variability and Predictability

Hypothesis 13

The hypothesis relating inter-individual variability to the prediction of cumulative GPA was:

When the cumulative GPA is the criterion, the prediction is equally accurate for those in the high variability group with low inter-individual variability as in the sub-groups of the aptitude test battery as those with high variability.

The multiple correlation coefficients for the low variability and high variability groups were .5734 and .3317 respectively. The corresponding F values were .6230 and .3270. There were 103 students in the low variability group and 115 in the high variability group. Thus, the test statistic was:

$$F = \frac{.5734^2 \times 103 \times 115}{.3317^2 \times 115} = 2.352$$

The value of the test statistic was significant at $\alpha = .05$ level. Consequently the null hypothesis of equal prediction accuracy for these two groups was rejected. It was concluded that students with low inter-individual variability in the sub-test scores of aptitude test battery were better predicted than those with high variability when the cumulative GPA is the criterion.

The variance that was explained by the predictors in the low variability group was thirty three percent, whereas the variance explained in high variability group was twelve percent. The estimate of increase in accuracy

of prediction is twenty one percent in terms of the explained criterion variance.

Hypothesis 14.

The corresponding hypothesis for test score GPA was:

When the test score GPA is the criterion, the prediction is equally accurate for those in the black population with low intra-individual variability in the sub-test scores of the aptitude test battery as those with high variability.

The multiple correlation coefficients for the low variability and high variability groups were .7635 and .5760 respectively. The corresponding Z values were 1.005 and .6565. There were 101 students in the low variability group and 115 in the high variability group. Thus the test statistic was:

$$Z = \frac{.3485 \times 104.57}{14.49} = 2.515$$

The value of the test statistic was significant at $\alpha = .05$ level. Consequently the null hypothesis was again rejected and it was concluded that test score GPA like cumulative GPA was better predicted for students with low intra-individual variability than for students with high variability in sub-test scores.

The percentage of variance explained in the low variability group was fifty eight and the percentage in the high variability group was only thirty three. The estimate of increase in accuracy of prediction for the low variability group was twenty in terms of explained variance.

of prediction is twenty one percent in terms of the explained criterion variance.

Hypothesis 14.

The corresponding hypothesis for test score GPA was:

When the test score GPA is the criterion, the prediction is equally accurate for those in the black population with low intra-individual variability in the sub-test scores of the aptitude test battery as those with high variability.

The multiple correlation coefficients for the low variability and high variability groups were .7635 and .5360 respectively. The unadjusted t values were 1.002 and .6565. There were 181 students in the low variability group and 115 in the high variability group. Thus the test statistic was

$$t = \frac{.7635 - .5360}{\sqrt{\frac{.0025}{181} + \frac{.0025}{115}}} = 1.212$$

The value of the test statistic was significant at $\alpha = .05$ level. Consequently the null hypothesis was again rejected and it was concluded that test score GPA like cumulative GPA was better predicted for students with low intra-individual variability than for students with high variability in sub-test scores.

The percentage of variance explained in the low variability group was fifty eight and the percentage in the high variability group was only thirty three. The estimate of increase in accuracy of prediction for the low variability group was twenty in terms of explained variance.

The analyses on the effectiveness of moderator variables revealed that sex and intra-individual variability successfully identified a subgroup of the population for whom prediction was more accurate than the other in the population. Whereas the variable of home background was not effective as a moderator variable. Sex was effective only when the cumulative GPA was the criterion. The estimate of improvement in prediction was twenty percent approximately. A ten percent improvement that was observed when the test score GPA was the criterion happened to be statistically non-significant. Intra-individual variability index was effective in the case of both criteria. When the cumulative GPA was the criterion, there was a twenty one percent improvement of prediction in the low variability group. When the test score GPA was the criterion, the improvement was twenty percent.

Summary

This chapter has presented the results of the statistical analyses performed on the data collected for the study. Results indicated that the use of linear regression equations based on aptitude variables was helpful in explaining a significant amount of variance in the cumulative GPA and in the test score GPA. This was true for both groups. The regression equations for the two groups were found to be significantly different in the case of

The analyses on the effectiveness of moderator variables revealed that sex and intra-individual variability successfully identified a subgroup of the population for whom prediction was more accurate than the other in the population. Whereas the variable of home background was not effective as a moderator variable, sex was effective only when the cumulative GPA was the criterion. The estimate of improvement in prediction was twenty percent approximately. A ten percent improvement was observed when the test score GPA was the criterion. The variable of intra-individual variability was not effective in the prediction of GPA. When the cumulative GPA was the criterion, there was a twenty one percent improvement in prediction. When the test score GPA was the criterion, the improvement was twenty percent.

Summary

This chapter has presented the results of the statistical analyses performed on the data collected for the study. Results indicated that the use of linear regression equations based on aptitude variables was helpful in explaining a significant amount of variance in the cumulative GPA and in the test score GPA. This was true for both groups. The regression equations for the two groups were found to be significantly different in the case of

both criteria. The partitioning procedure revealed the differing contribution of factors 1 and 2 when the cumulative GPA was the criterion and of factor 1 when the test score GPA was the criterion. Factor 1 explained a significantly higher percentage of variance in group I than in group II. Factor 2, however, explained a significantly higher percentage of variance in group II than in group I. The overall variance that was accounted for by all the factors together was the same when the cumulative GPA was the criterion. There was a significant difference when the test score GPA was the criterion. A significantly larger proportion of criterion variance was explained in group I than in group II when the test score GPA was the criterion.

An examination of the scatter diagrams led to the conclusion that a linear regression model would be the best fit for the data. Curvilinear regressions would not in any way augment the accuracy of prediction. The use of high school grade point average in addition to the aptitude variables as predictors resulted in significant improvement in predicting both criteria in the case of blacks. The estimated improvement was six percent in both criteria. The variables of sex and intra-individual variability index were found to be effective as moderator variables. There was a twenty percent improvement in the prediction of the cumulative GPA for females over males. Approximately

both criteria. The partitioning procedure revealed the differing contribution of factors 1 and 2 when the cumulative GPA was the criterion and of factor 1 when the test score GPA was the criterion. Factor 1 explained a significantly higher percentage of variance in group I than in group II. Factor 2, however, explained a significantly higher percentage of variance in group II than in group I. The overall variance that was accounted for by all the factors together was the same when the cumulative GPA was the criterion. There was a significant difference when the test score GPA was the criterion. A significantly larger amount of criterion variance was explained in group I than in group II when the test score GPA was the criterion.

An examination of the scatter diagrams led to the conclusion that a linear regression model would be the best fit for the data. Curvilinear regressions would not in any way augment the accuracy of prediction. The use of high school grade point average in addition to the aptitude variables as predictors resulted in significant improvement in predicting both criteria in the case of blacks. The estimated improvement was six percent in both criteria. The variables of sex and intra-individual variability index were found to be effective as moderator variables. There was a twenty percent improvement in the prediction of the cumulative GPA for females over males. Approximately

twenty percent improvement was achieved in the low variability group in predicting both the cumulative GPA and the test score GPA.

Chapter V will deal with the interpretation of the results.

twenty percent improvement was achieved in the low ability group in predicting both the cumulative GPA and the last score GPA. Chapter V will deal with the interpretation of the results.

CHAPTER V

SUMMARY AND CONCLUSIONS

This chapter presents an overview of the research reported. The results of the research are discussed and suggestions for further research are made.

Overview

This study explored three major research questions:

1. Is the same rule of prediction applicable to blacks and whites while using aptitude test variables to predict college success? The rule of prediction is a linear regression equation. The same rule of prediction is applicable to blacks and whites only if the regression surfaces represented by the equations for these two groups are homogeneous. Thus the question becomes: Are the regression surfaces for blacks and whites homogeneous? The ultimate aim was to discover whether the use of aptitude test scores with the same regression equation to predict college success for blacks and whites would be biased against blacks.

2. How much of the criterion variance is explained by the aptitude variables in the two groups?

CHAPTER V

SUMMARY AND CONCLUSIONS

This chapter presents an overview of the research reported. The results of the research are discussed and suggestions for further research are made.

Overview

This study explored three major research questions:

1. In the same type of prediction applicable to blacks and whites while using aptitude test variables to predict college success, the rate of prediction is a linear regression equation. The same rule of prediction is applicable to blacks and whites only if the regression surfaces represented by the equations for these two groups are homogeneous. Thus the question becomes: Are the regression surfaces for blacks and whites homogeneous? The ultimate aim was to discover whether the use of aptitude test scores with the same regression equation to predict college success for blacks and whites would be biased against blacks.
2. How much of the criterion variance is explained by the aptitude variables in the two groups?

Is there a significant difference in the multiple correlation coefficients between the criterion and the aptitude variables for the two groups.

3. Can the accuracy of prediction in the case of blacks be improved by the use of curvilinear models, by the use of high school GPA in addition to the aptitude variables and by the use of moderator variables?

The samples selected for the study were from the population of freshmen who entered Michigan State University in fall, 1968 and who completed the winter term 1970. ^{one sample} Sample one consisted of all black students who had complete data for various comparisons. For one set of comparisons the black sample was 224 and for another set of comparisons it was 216. Sample two consisted of students randomly chosen from the white population. Its size for one set of comparisons was 511 and for another 268.

The principal instruments in the study were MSU English, MSU Reading, and the College Qualification Test (CQT) with three subtests of Verbal, Informational, and Numerical abilities. The scores on these tests were used in multiple regression to predict college success defined in terms of the cumulative GPA at the end of winter term 1970 and a test score GPA which was based on the grades received in the basic college courses taken during the same period. The basic college courses included courses in American Thought and Language, Humanities, Natural Science, and Social Science.

Is there a significant difference in the multiple correlation coefficients between the criterion and the aptitude variables for the two groups.

3. Can the accuracy of prediction in the case of blacks be improved by the use of curvilinear models, the use of high school GPA in addition to the aptitude variables and by the use of moderator variables?

The samples selected for the study were from the population of freshmen who entered Michigan State University in fall, 1968 and who completed the winter term 1970. Samples consisting of 100 blacks and 100 whites who had complete data for various aptitude tests, the use of composite data for various aptitude tests, and for another set of comparisons the black sample was 50 and the white sample was 50. It was found that the sample consisted of students randomly chosen from the white population. The size for one set of comparisons was 50 and for another 268.

The principal instruments in the study were MSU English, MSU Reading, and the College Qualification Test (CQT) with three subtests of Verbal, Informational, and Numerical abilities. The scores on these tests were used in multiple regression to predict college success defined in terms of the cumulative GPA at the end of winter term 1970 and a test score GPA which was based on the grades received in the basic college courses taken during the same period. The basic college courses included courses in American Thought and Language, Humanities, Natural Science, and Social Science.

After establishing the fit of the linear model in regression, the two groups were compared in terms of the regression functions and the proportion of criterion variance explained by aptitude variables. These comparisons were made using the cumulative GPA and the test score GPA. Improved prediction accuracy in the case of blacks was attempted by exploring the possibility of the use of curvilinear regression, by the use of high school GPA in addition to the aptitude variables, and by the use of moderator variables. The moderator variables were not used in the regression equation but as basis for identifying homogeneous subgroups in terms of increased prediction accuracy.

The major statistical tools employed in the study were factor analysis, Z tests, and Variance Ratio Tests. The decision rule in all tests was to reject the null hypothesis at $\alpha = .05$ level of type I error.

Results showed that the regression equations for the two groups were significantly, though not substantially different. The regression equation for blacks predicted criterion values that were slightly lower than those that would be predicted from the white or common regression equation.

The partitioning procedure revealed the differing contributions of factors 1 and 2 in predicting the criteria. Factor 1 might be described as Verbal Ability Factor since

After establishing the fit of the linear model in regression, the two groups were compared in terms of the regression functions and the proportion of criterion variance explained by aptitude variables. These comparisons were made using the cumulative GPA and the test score GPA. Improved prediction accuracy in the case of blacks was attempted by exploring the possibility of the use of curvilinear regression, by the use of high school GPA in addition to the aptitude variables, and by the use of moderator variables. The moderator variables were not used in the regression analysis but as tests for identifying homogeneous subgroups. The use of increased prediction accuracy.

The major statistical tests employed in the study were factor analysis, ANOVA, and Variance Ratio Tests. The decision rule in all tests was to reject the null hypothesis at a $\alpha = .05$ level of type I error.

Results showed that the regression equations for the two groups were significantly, though not substantially different. The regression equation for blacks predicted criterion values that were slightly lower than those that would be predicted from the white or common regression equation.

The partitioning procedure revealed the differing contributions of factors I and II in predicting the criteria. Factor I might be described as Verbal Ability factor since

it has the highest factor loading (.8100) on the CQT-Verbal subtest. Factor 2 might be described as Numerical Ability Factor since it has the highest factor loading (-.9225) on the CAT-Numerical subtest.

Both groups were found to be equally predictable in terms of the cumulative GPA. The test score GPA of the blacks were better predicted than the test score GPA of the whites.

An examination of scatter diagrams showed that curvilinear models held no promise of improving prediction accuracy over that achieved by linear model. The addition of high school GPA to the set of aptitude variables resulted in six percent improvement with respect to the criterion variance explained by the aptitude variables. The six percent improvement was found to be statistically significant. Sex and intra-individual variability index were effective as moderator variables. Females were better predicted than males with respect to the cumulative GPA, but not the test score GPA. Both criteria were better predicted for the low intra-individual variability group than for the high variability group.

The implications of these results are taken up in the next section.

it has the highest factor loading (.8100) on the CQT-Verbal subscale. Factor 2 might be described as Numerical Ability Factor since it has the highest factor loading (.9225) on the CAT-Numerical subscale.

Both groups were found to be equally predictable in terms of the cumulative GPA. The test score GPA of the blacks were better predicted than the test score GPA of the whites.

An examination of scatter diagrams showed that curvilinear models held no promise at improving prediction accuracy over that obtained by linear model. The addition of high school GPA as an additional variable resulted in six percent improvement with respect to the criterion variance explained by the regression variables. The six percent improvement was found to be statistically significant. Sex and intra-individual variability index were effective as moderator variables. Females were better predicted than males with respect to the cumulative GPA, but not the test score GPA. Both criteria were better predicted for the low intra-individual variability group than for the high variability group.

The implications of these results are taken up in the next section.

Discussion of Results

The first research question the study attempted to answer was the homogeneity of regressions for blacks and whites. The regressions in question were linear in form. Before the regressions were compared for homogeneity, the appropriateness of linearity was examined in terms of its ability to explain a substantial proportion of the criterion variance.

In both groups the use of linear regression equations predicted a significant amount of the criterion variance. This was true in the case of the cumulative GPA and the test score GPA. Therefore it was concluded that the linear model fit the data satisfactorily. A linear fit in this context was defined to be the ability of the model to predict a significant amount of the variance in the criterion. Given this definition, it is possible that a linear model fits a given set of data and at the same time a curvilinear model fits the same set of data equally well or better. Hence at this point no decision was made about the possibility of improved prediction accuracy by the use of curvilinear models.

Regression equations for predicting the cumulative GPA and the test score GPA were found to be significantly different for the two groups. In both cases the regression coefficients were generally lower for blacks than for whites. This is indication that the use of white or common regression equation would result in overestimates of the criterion

Discussion of Results

The first research question the study attempted to answer was the homogeneity of regressions for blacks and whites. The regressions in question were linear in form. Before the regressions were compared for homogeneity, the appropriateness of linearity was examined in terms of its ability to explain a substantial proportion of the criterion variance.

In both groups the use of a linear regression equation predicted a significant amount of the criterion variance. This was true for both the cumulative GPA and the test score GPA. It was concluded that the linear model fit the data satisfactorily. A linear fit in this context was a good indication of the ability of the model to predict a significant amount of the variance in the criterion. Given this information it is possible that a linear model fits a given set of data and at the same time a curvilinear model fits the same set of data equally well or better. Hence at this point no decision was made about the possibility of improved prediction accuracy by the use of curvilinear models.

Regression equations for predicting the cumulative GPA and the test score GPA were found to be significantly different for the two groups. In both cases the regression coefficients were generally lower for blacks than for whites. This is indication that the use of white or common regression equation would result in overestimates of the criterion

values for blacks. This finding is opposed to what has been anticipated. It was anticipated that the relatively richer environment of an integrated University like Michigan State would provide the needed stimulation for the blacks to achieve higher than what would be predicted on the basis of common regression and consequently the criterion estimates from a separate regression would generally be higher than those from common regression estimates.

The reason why the environment at Michigan State did not have the expected influence on the academic achievement of blacks would be a matter of conjecture and speculation. It might be that the content of majority of the courses offered at Michigan State was perceived to be irrelevant to the blacks as a group and as a result they were not motivated to learn them. It might be that more supportive programs would be needed before they would be able to take full advantage of the new environment. Further research would be needed before one can make definitive statements about the apparent ineffectiveness of the relatively richer environment of an integrated University like Michigan State on the academic achievement of blacks.

The difference obtained in the regression coefficients for the two groups in the study, though statistically significant, ~~is not significant~~ does not appear to be meaningful or substantial. Firstly, the numerical difference between the regression coefficients in the two groups is very small.

values for blacks. This finding is opposed to what has been anticipated. It was anticipated that the relatively richer environment of an integrated University like Michigan State would provide the needed stimulation for the blacks to achieve higher than what would be predicted on the basis of common regression and consequently the criterion estimates from a separate regression would generally be higher than those from the common regression estimates.

The reason why the students at Michigan State did not have the expected advantage in the academic achievement of blacks would be that the quality of the courses offered at Michigan State was reserved to be irrelevant to the blacks as a group and as a result they were not motivated by the courses. It might be that more supportive programs would be needed before they would be able to take full advantage of the new environment. Further research would be needed before one can make definitive statements about the apparent ineffectiveness of the relatively richer environment of an integrated University like Michigan State on the academic achievement of blacks.

The difference obtained in the regression coefficients for the two groups in the study, though statistically significant, does not appear to be meaningful or substantial. Firstly, the numerical difference between the regression coefficients in the two groups is very small.

Unaltered
LS
Delete +
LS ADD
OK R. J. H.

Secondly, the difference in the predicted $\hat{Y}$'s using the different equations on the same set of data is also very small. In other words the use of either equation will not show a large difference in the estimated criterion values. For example, the use of black regression on one set of data resulted in a value of 2.582, and the use of white regression on the same set of data resulted in a value of 2.742, the difference being only .16. A statistically significant difference need not always be a meaningful or substantial difference. A statistical test will show a small difference as significant if the sample size of the groups involved is large. Such appears to be the case in this study.

The fact that the criterion values predicted from the black regression equation were lower than the criterion values that would be predicted from a common or white regression equation leads to the conclusion that the use of the same regression equation for blacks and whites would not be biased against the blacks. These results and conclusions agree with those of Cleary (1968) who studied the bias of Scholastic Aptitude Test as predictor of college grades. She concluded her findings as follows (Cleary, 1968, p. 123):

The schools used in this study do not represent the spectrum of colleges in the United States, so general conclusions cannot be reached. In the three colleges studied, however, there was little evidence that the Scholastic Aptitude Test is

Secondly, the difference in the predicted Y's using the different equations on the same set of data is also very small. In other words the use of either equation will not show a large difference in the estimated criterion values. For example, the use of black regression on one set of data resulted in a value of 2.583, and the use of white regression on the same set of data resulted in a value of 2.743, the difference being only 0.16. A statistically significant difference need not always be a meaningful or substantial difference. A small difference will show a small difference as significant if the sample size of the groups involved is large. This may be the case in this study.

The fact that the predicted values predicted from the black regression equation were lower than the criterion values that would be predicted from a common or white regression equation leads to the conclusion that the use of the same regression equation for blacks and whites would not be biased against the blacks. These results and conclusions agree with those of Cleary (1968) who studied the bias of Scholastic Aptitude Test as predictor of college grades. She concluded her findings as follows (Cleary, 1968, p. 123):

The schools used in this study do not represent the spectrum of colleges in the United States, so general conclusions cannot be reached. In the three colleges studied, however, there was little evidence that the Scholastic Aptitude Test is

biased as a predictor of college grades. In the two eastern schools, there were not significant differences in the regression lines for Negro and white students. In the one college in the southwest, the regression lines for Negro and white students were significantly different: the Negro students' scores were overpredicted by the use of the white or common regression lines.

The final conclusion arising from the comparison of the regression equations must be tempered by the consideration that in regression theory the independent variables are assumed to be measured without error, i.e., they are perfectly reliable. Clearly MSU Reading, MSU English, and CQT are not perfectly reliable. If departures from perfect reliability were to be the same for the two groups, the results of the comparison of regression equations would not be altered. However, if the errors of measurement in the independent variables were to be different in the two groups, this would affect the results of the comparison.

The second question to which this study addressed was the amount of variance explained by the aptitude variables for each group. The proportion of variance explained by the predictors is an index of how good the regression is. If a significantly lesser proportion of variance is explained by the predictors in the case of blacks than in the case of whites, the prediction might be considered unfair for blacks.

biased as a predictor of college grades. In the two eastern schools, there were not significant differences in the regression lines for Negro and white students. In the one college in the southeast, the regression lines for Negro and white students were significantly different: the Negro students' scores were overpredicted by the use of the white or common regression lines.

The final conclusion arising from the comparison of the regression equations must be tempered by the consideration that in regression theory the independent variables are assumed to be measured without error, i.e., they are perfectly reliable. If the English, Spanish, and GQT are not perfectly reliable, if departures from perfect reliability were to be the same for the two groups, the results of the two sets of regression equations would not be altered. However, if the errors of measurement in the independent variables were to be different in the two groups, this would affect the results of the comparison.

The second question to which this study addressed was the amount of variance explained by the aptitude variables for each group. The proportion of variance explained by the predictors is an index of how good the regression is. If a significantly lesser proportion of variance is explained by the predictors in the case of blacks than in the case of whites, the prediction might be considered unfair for blacks.

An analysis of the multiple correlations between the aptitude variables and the cumulative GPA for blacks and whites did not show any significant difference. The aptitude variables predicted the cumulative GPA equally well for blacks and whites. In the white sample studied, twenty eight percent of the criterion variance was accounted for by the aptitude variables and in the black sample twenty six percent of the criterion variance was explained by the aptitude variables.

In predicting the test score GPA, the accuracy level was found to be higher for blacks than for whites. Analysis of the multiple correlations revealed that the difference in the accuracy level was significant. In the black sample fifty-nine percent of the criterion variance was explained by aptitude variables, whereas in the white sample only forty-three percent of the criterion variance was explained by the aptitude variables.

The overall conclusion is that prediction of college success from MSU English, MSU Reading, and the College Qualification Test is equally valid and reliable for blacks and whites at Michigan State University.

However, the differing contributions for the two groups of factors 1 and 2 (Verbal Ability Factor and Numerical Ability Factor) in predicting the cumulative GPA and of factor 1 in predicting the test score GPA was brought to light in the partitioning procedures. Factor 1 explained

An analysis of the multiple correlations between the aptitude variables and the cumulative GPA for blacks and whites did not show any significant difference. The aptitude variables predicted the cumulative GPA equally well for blacks and whites. In the white sample studied, twenty eight percent of the criterion variance was accounted for by the aptitude variables and in the black sample twenty six percent of the criterion variance was explained by the aptitude variables.

In predicting the test scores, the accuracy level was found to be higher for blacks than for whites. Analysis of the multiple correlations revealed that the difference in the relationship was significant. In the black sample fifty-nine percent of the criterion variance was explained by aptitude variables, whereas in the white sample only forty-three percent of the criterion variance was explained by the aptitude variables.

The overall conclusion is that prediction of college success from MSU English, MSU Reading, and the College Qualification Test is equally valid and reliable for blacks and whites at Michigan State University. However, the differing contributions for the two groups of factors 1 and 2 (Verbal Ability Factor and Numerical Ability Factor) in predicting the cumulative GPA and of factor 1 in predicting the test scores GPA was brought to light in the partitioning procedures. Factor 1 explained

a significantly higher percentage of criterion variance in the blacks (four percent) than in the whites (.25 percent) when the cumulative GPA was the criterion. Factor 2 explained .25 percent in the blacks and three percent in the whites. When the test score GPA was the criterion, factor 1 still differed in the proportion of contribution in the two groups. Factor 1 explained sixteen percent in the blacks and three percent of the criterion variance in the whites.

The low correlations and consequent proportion of explained variance might be due to either lack of range or due to lack of true relationship in the data. The correlation between factor 1 and the cumulative GPA in the whites was only .05, but in the case of the test score GPA the correlation was .17. This increase in correlation leads one to believe that the low correlations cannot be attributed to lack of range, but is a reflection of the true relationship. The same reasoning is applicable to factor 2, the correlation of which with the cumulative GPA in the blacks was only .05, but with the test score GPA it was .14. Thus the low correlation may be said to reflect the true state of affairs, namely the Numerical Ability Factor is almost uncorrelated with the cumulative GPA in the blacks.

Finally this study sought to improve prediction accuracy in the case of black students by exploring the

a significantly higher percentage of criterion variance in the blacks (four percent) than in the whites (.35 percent) when the cumulative GPA was the criterion. Factor 2 explained .35 percent in the blacks and three percent in the whites. When the test score GPA was the criterion, factor 1 still differed in the proportion of contribution in the two groups. Factor 1 explained sixteen percent in the blacks and three percent of the criterion variance in the whites.

The low correlations and consequent proportion of explained variance might be due to either lack of range or due to lack of true relationship in the data. The correlation between factor 1 and the cumulative GPA in the whites was only .02, but in the case of the test score GPA the correlation was .17. This increase in correlation leads one to believe that the low correlations cannot be attributed to lack of range, but is a reflection of the true relationship. The same reasoning is applicable to factor 2: the correlation of which with the cumulative GPA in the blacks was only .02, but with the test score GPA it was .14. Thus the low correlation may be said to reflect the true state of affairs, namely the Numerical Ability factor is almost uncorrelated with the cumulative GPA in the blacks.

Finally this study sought to improve prediction accuracy in the case of black students by exploring the

possibility of using curvilinear regression, by the use of high school GPA in addition to the aptitude variables and by the use of moderator variables to identify individuals of high predictability.

Visual inspection of scatter diagrams associated with each of the independent variables and each of the criteria showed that the use of curvilinear models would not reduce the errors of prediction any more than the linear model. However, visual inspection is not as accurate as analytical procedures. Higher degree polynomials might be hypothesized to be good fit of the data and the regression coefficients associated with the higher terms of the polynomial could be tested for significance. This procedure would provide more accurate results than the visual inspection undertaken in this study.

When high school GPA was added to the regression equation, the increment in the explained criterion variance in the case of blacks was significantly different from zero both in the cumulative GPA and in the test score GPA. The proportion of variance in the cumulative GPA explained by aptitude variables alone was .2731 whereas after the high school GPA was added it was .3305. The proportion of variance in the test score GPA explained by the aptitude variables alone was .5911 and after high school GPA it was .6509. Thus it was concluded that college achievement, measured in terms of the cumulative GPA or

possibility of using curvilinear regression, by the use of high school GPA in addition to the aptitude variables and by the use of moderator variables to identify individuals of high predictability.

Visual inspection of scatter diagrams associated with each of the independent variables and each of the criteria showed that the use of curvilinear models would not reduce the errors of prediction any more than the linear model. However, visual inspection is not as accurate as analytical procedures. Higher degree polynomials might be hypothesized for the data and the regression coefficients tested with a higher series of the polynomial could be tested for significance. This procedure would provide more accurate results than the visual inspection undertaken in this study.

When high school GPA was added to the regression equation, the increment in the explained criterion variance in the case of blacks was significantly different from zero both in the cumulative GPA and in the test score GPA. The proportion of variance in the cumulative GPA explained by aptitude variables alone was .2731 whereas after the high school GPA was added it was .3302. The proportion of variance in the test score GPA explained by the aptitude variables alone was .2511 and after high school GPA it was .3209. Thus it was concluded that college achievement, measured in terms of the cumulative GPA or

the test score GPA, was better predicted by adding the high school GPA to the aptitude variables in the case of black students.

The conclusion of this study with respect to the contribution of high school GPA might be compared with the conclusion arrived at by Thomas and Stanley (1969) after reviewing a number of studies on the effectiveness of high school grades for predicting college grades of black students. They stated that "evidence seems to suggest that high school grades do not consistently contribute the most to predicting the college grades of black students, perhaps particularly of men, whereas they do for whites." (1969, p. 204). The concern in this study was not comparison of blacks and whites with respect to the contribution of high school grades in prediction of college success, but the absolute improvement effected in the black population alone. It is possible and likely that the contribution in whites is greater than in blacks. This study has shown that the absolute improvement in prediction is significant and worthwhile in blacks, when high school GPA is added to the aptitude variables.

Analyses on the effectiveness of moderator variables revealed that sex and intra-individual variability index could be used to identify subgroups of blacks for whom better prediction would be possible. One of the psychometric implications of this result is the possibility

the test score GPA, was better predicted by adding the high school GPA to the aptitude variables in the case of black students. The conclusion of this study with respect to the contribution of high school GPA might be compared with the conclusion arrived at by Thomas and Stanley (1969) after reviewing a number of studies on the effectiveness of high school grades for predicting college grades of black students. They stated that "evidence seems to suggest that high school grades do not consistently contribute the most to predicting the college grades of black students, perhaps particularly at the lower end of the scale as they do for whites." (1969, p. 204). The concern in this study was not comparison of blacks and whites with respect to the contribution of high school grades in prediction of college success, but the absolute improvement effected in the black population alone. It is possible and likely that the contribution in whites is greater than in blacks. This study has shown that the absolute improvement in prediction is significant and worthwhile in blacks, when high school GPA is added to the aptitude variables. Analyses on the effectiveness of moderator variables revealed that sex and intra-individual variability index could be used to identify subgroups of blacks for whom better prediction would be possible. One of the psychometric implications of this result is the possibility

of discovering subgroups of individuals for whom a particular test or set of tests will be specially effective for predictive purposes. The result has also implication in counselling. Counselors are concerned from time to time with providing information to students regarding academic prognoses. The results of this study have shown that the accuracy with which this can be done is a function of characteristics like sex and intra-individual variability index. Females were better predicted than males, and similarly individuals of low intra-individual variability were better predicted than those with high variability. Still another implication of the results regarding the effectiveness of moderator variables is that it can provide hints about the dynamics of personality characteristics in college achievement. This study was not planned to investigate what personality dynamics are operating to produce academic achievement. However, by demonstrating that differentially accurate predictions can be made for students classified on moderator variables, the study has provided support for the position that personality characteristics may play an important role in academic achievement.

Suggestions for Further Research

In regression theory it is assumed that the independent variables are measured without error. This means

of discovering subgroups of individuals for whom a particular test or set of tests will be especially effective for predictive purposes. The result has also implication in counseling. Counselors are concerned from time to time with providing information to students regarding academic progress. The results of this study have shown that the accuracy with which this can be done is a function of characteristics like sex and personality variables. Females were better predictors than males, and similarly individuals of high personality stability were better predictors than those with low stability. Still another implication of the results regarding the effectiveness of moderator variables is that it can provide hints about the dynamics of personality characteristics in college achievement. This study was not planned to investigate what personality dynamics are operating to produce academic achievement. However, by demonstrating that differentially accurate predictions can be made for students classified on moderator variables, the study has provided support for the position that personality characteristics may play an important role in academic achievement.

Suggestions for Further Research

In regression theory it is assumed that the independent variables are measured without error. This means

that they are perfectly reliable. Clearly this is an assumption that can be hardly met in social and behavioral sciences. Hence methods of correcting the influence of unreliability resulting from errors of measurement have been proposed by Cochran (1968). Investigations are needed that incorporate these methods of correction for unreliability in the independent variables.

Irrelevancy of curriculum for blacks and lack of special intervention techniques to compensate for earlier disadvantages were suggested as possible explanations for the apparent ineffectiveness of the environment of an integrated university like Michigan State to improve the academic achievement of the black students. These conjectures require further research and experimentation.

This research demonstrated the usefulness of high school GPA as additional predictor in multiple prediction of college success in the case of blacks at Michigan State University. A possibility for future research would be to compare blacks and whites with respect to the improvement in prediction from adding high school scholarship to the aptitude variables.

The moderator variables used in this research were treated as dichotomies for the purpose of identifying the individuals of higher predictability. Better methods of accomplishing this purpose might be developed. It should be possible to employ a continuous measure of each variable

that they are perfectly reliable. Clearly this is an assumption that can be hardly met in social and behavioral sciences. Hence methods of correcting the influence of unreliability resulting from errors of measurement have been proposed by Cochran (1958). Investigations are needed that incorporate these methods of correction for unreliability in the independent variables.

Irrelevance of explanation for blacks and lack of special intervention techniques to compensate for earlier disadvantages were suggested as possible explanations for the apparent influence of the environment of an integrated university. The Michigan State to improve the academic achievement of black students. These conclusions require further testing and experimentation. This research demonstrated the usefulness of high school GPA as additional predictor in multiple prediction of college success in the case of blacks at Michigan State University. A possibility for future research would be to compare blacks and whites with respect to the improvement in prediction from adding high school scholarship to the aptitude variables.

The moderator variables used in this research were treated as dichotomies for the purpose of identifying the individuals of higher predictability. Better methods of accomplishing this purpose might be developed. It should be possible to employ a continuous measure of each variable

rather than a dichotomy. Methods might be developed to facilitate the discovery of variables which relate to the predictive value of a test.

Another possibility for future research is an extension of the study to include criteria at different intervals to find out whether the same relationships found in this study hold across time.

rather than a dichotomy. Methods might be developed to facilitate the discovery of variables which relate to the predictive value of a test.

Another possibility for future research is an extension of the study to include criteria at different intervals to find out whether the same relationships found in this study hold across time.

BIBLIOGRAPHY

- Ausubel, D. P., and Ausubel, Pearl, 1963, "Ego Development among Segregated Negro Children," In A. H. Passow, Education in Depressed Areas. New York: Teachers College, Columbia University, 1963, p. 109-141.
- Baggaley, Andrew R., 1964, Intermediate Correlation Methods, John Wiley and Sons, Inc., New York.
- Beatley, B., 1922, "The Relative Standing of Students in Secondary School in Comprehensive Entrance Examinations and in College," School Review, 30, 141-147.
- Bennett, George K. and others, 1957, College Qualification Tests Manual, New York: The Psychological Corporation.
- Berdie, R. F., Dressel, P. L., and Kelso, P. C., 1951, "Relative Validity of the Q and L scores of the ACE Psychological Examination," Educational and Psychological Measurement, 11, 803-812.
- Berdie, R. F., 1961, "Intra-individual Variability and Predictability," Educational and Psychological Measurement, 21, 663-676.
- Biaggio, Angella M. B. and Stanley, Julian C., 1964, Prediction of Freshmen Grades at Southern State Colleges. Paper presented at the Ninth Inter American Congress of Psychology, Miami, December 1964.
- Blalock, H. M., 1963, "Correlated Independent Variables: The Problem of Multicollinearity," Social Forces, 42, 233-237.
- Bloom, Benjamin S. and Peters, Frank R., 1961, The Use of Academic Prediction Scales for Counselling and Selecting College Entrants, The Free Press of Glencoe, Inc., New York.
- Bloom, Benjamin S., 1964, Stability and Change in Human Characteristics, New York: Wiley and Sons.

- Boney, J. D., 1966, "Predicting the Academic Achievement of Secondary School Negro Students," Personnel and Guidance Journal, 44, 700-703.
- Brown, Frederick G. and Scott, David A., 1966, "The Unpredictability of Predictability," Journal of Educational Measurement, 3, 297-302.
- Bruce, William J., 1953, "The Contribution of Eleven Variables to the Prognosis of Academic Success in Eight Areas at the University of Washington," Unpublished Doctoral Dissertation, University of Washington, Seattle, 1953.
- Campbell, J., 1964, Testing of Culturally Different Groups, Research Bulletin 64-34, Princeton, N.J., Educational Testing Service.
- Clark, Kenneth B. and Plotkin, L., 1963, The Negro Student at Integrated Colleges, New York: National Scholarship Service and Fund for Negro Students.
- Cleary, T. Anne, 1968, "Test Bias: Prediction of Grades of Negro and White Students," Journal of Educational Measurement, 5, 115-124.
- Cochran, W. W., 1968, "Errors of Measurement in Statistics," Technometrics, 10, 637-666.
- Cochrane, D. and Orcutt, G. H., 1949, "Application of Least Squares Regression to Relationships Containing Auto-correlated Error Terms," Journal of American Statistical Association, 44, 48-51.
- Cosand, Joseph P., 1953, "Admissions Criteria: A Report of the California Committee for the Study of Education," College and University, 28, 338-364.
- Cronbach, Lee J., 1949, Essentials of Psychological Testing, New York: Harper and Brothers.
- Darlington, Richard B., 1968, "Multiple Regression in Psychological Research and Practice," Psychological Bulletin, 69, 161-182.
- Deutsch, M., 1963, "The Disadvantaged Child and the Learning Process," In A. H. Passow, Education in Depressed Areas, 1963, New York: Teachers College, Columbia University, 163-180.

Boney, J. D., 1966, "Predicting the Academic Achievement of Secondary School Negro Students," Personnel and Guidance Journal, 44, 700-703.

Brown, Frederick G. and Scott, David A., 1966, "The Unpredictability of Predictability," Journal of Educational Measurement, 3, 297-303.

Bryce, William J., 1953, "The Contribution of Eleven Variables to the Prediction of Academic Success in Eight Areas at the University of Washington," Unpublished Doctoral Dissertation, University of Washington, Seattle, 1953.

Campbell, J., 1964, "Testing of Individually Different Groups," Research Bulletin 64-10, Princeton, N.J. Educational Testing Service.

Clark, Kenneth B. and Robinson, J. (1965), The Negro Student at Integrated Schools, New York: National-Scholarship Service and the Negro Students.

Cleary, T. Anne, 1955, "The Effect of Grades of Negro and White Students," Journal of Educational Measurement, 2, 101-114.

Cochran, W. W., 1958, "Methods of Measurement in Statistics," Technometrics, 10, 451-465.

Cochrane, D. and Grout, G. W., 1949, "Application of Least Squares Regression to Relationships Containing Auto-correlated Error Terms," Journal of the American Statistical Association, 44, 48-57.

Coand, Joseph P., 1953, "Admissions Criteria: A Report of the California Committee for the Study of Education," College and University, 28, 339-364.

Cronbach, Lee J., 1949, Essentials of Psychological Testing, New York: Harper and Brothers.

Darlington, Richard B., 1968, "Multiple Regression in Psychological Research and Practice," Psychological Bulletin, 69, 161-182.

Deutsch, M., 1963, "The Disadvantaged Child and the Learning Process," in A. H. Passow, Education in the Pressed Areas, 1963, New York: Teachers College, Columbia University, 163-180.

- Durbin, J. and Watson, G. S., 1950, "Testing for Serial Correlation in Least Squares Regression," Bio-metrika, 37.
- Ezekiel, Mordecai and Fox, Karl A., 1959, Methods of Correlation and Regression Analysis, Linear and Curvilinear, 3rd ed., Wiley and Sons.
- Fisher, R. A., 1942, The Design of Experiments, (Ed. 3), Edinburgh: Oliver and Boyd.
- Fishman, Joshua A., Deutsch, M., Kogan, L., North, R., and Whiteman, R., 1964, "Guidelines for Testing Minority Children," Journal of Social Issues Supplement, 20, 129-145.
- Fishman, Joshua A. and Pasanella, Ann K., 1960, "College Admissions In Selection Studies," Review of Educational Research, 30, 298-231.
- Fishman, Joshua A., 1958, "Unsolved Criterion Problems in the Selection of College Students," Harvard Educational Review, 28, 320-329.
- Frederiksen, N. and Gilbert, A. C., 1960, "Replication of a Study of Differential Predictability," Educational and Psychological Measurement, 20, 759-767.
- Frederiksen, Norman and Melville, S. Donald, 1960, "Differential Predictability in the Use of Test Scores," Educational and Psychological Measurement, 20, 647-656.
- Funches, D., 1967, "Correlations between Secondary School Transcript Averages and between ACT Scores and Grades Point Averages of Freshmen at Jackson State College," College and University, 43, 52-54.
- Garrett, Harley F., 1949, "A Review and Interpretation of Investigations of Factors Related to Scholastic Success in Colleges of Arts and Science and Teachers Colleges," The Journal of Experimental Education, 18, 91-138.
- Garrett, H. E., 1937, Statistics in Psychology and Education, Longmans, Green and Co., New York.
- Ghiselli, Edwin E., 1956, "Differentiation of Individuals in Terms of Their Predictability," Journal of Applied Psychology, 40, 374-377.

- Dubin, J. and Watson, G. B., 1950, "Testing for Serial Correlation in Least Squares Regression," Biometrika, 37.
- Erskine, Harold and Fox, Karl A., 1953, Methods of Correlation and Regression Analysis, Linear and Non-Linear, 3rd ed., Wiley and Sons.
- Fisher, R. A., 1942, The Design of Experiments, (Ed. 2), Edinburgh: Oliver and Boyd.
- Fishman, Joshua A., Deutsch, M., Kogan, J., North, R., and Whitman, R., 1964, "Guidelines for Testing Minority Children," Journal of Social Issues Supplement, 20, 129-145.
- Fishman, Joshua A. and Friedman, M., 1960, "College Admissions in the United States: A Review of Educational Research," Journal of Educational Research, 53, 1-10.
- Fishman, Joshua A., 1961, "The Educational Problems in the Selection of College Students," Harvard Educational Review, 31, 1-10.
- Frederiksen, N. and Gulliksen, H., 1957, "Replication of a Study of Intelligence, Achievement, and Educational and Psychological Measurement," Journal of Educational Research, 50, 759-767.
- Frederiksen, Norman and Gulliksen, H., 1960, "Differential Predictability in the Use of Test Scores," Educational and Psychological Measurement, 20, 547-556.
- Funchess, D., 1967, "Correlations between Secondary School Transcript Averages and between ACT Scores and Grade Point Averages of Freshmen at Jackson State College," College and University, 41, 52-54.
- Gartt, Harvey F., 1949, "A Review and Interpretation of Investigations of Factors Related to Scholastic Success in Colleges of Arts and Science and Teaching Colleges," The Journal of Experimental Education, 18, 91-138.
- Gartt, H. F., 1957, Statistics in Psychology and Education, Longmans, Green and Co., New York.
- Gissell, Edwin H., 1956, "Differentiation of Individuals in Terms of Their Predictability," Journal of Applied Psychology, 40, 374-377.

- Ghiselli, Edwin E., 1960, "The Prediction of Predictability," Educational and Psychological Measurement, 20, 3-8.
- Graff, Robert W. and Hansen, James C., 1970, "Relationship of OAIS Scores to College Achievement and Adjustment," Journal of College Student Personnel, 11, 129-135.
- Green, Robert L. and Farquhar, William W., 1965, "Negro Academic Motivation and Scholastic Achievement," Journal of Educational Psychology, 56, 241-243.
- Green, Robert L., 1969, "The Black Quest for Higher Education: An Admissions Dilemma," Personnel and Guidance Journal, 47, 905-911.
- Hartnett, Rodney T., 1963, "An Analysis of Factors Associated with Changes in Scholastic Performance Patterns," Unpublished Doctoral Dissertation, Michigan State University.
- Hays, William L., 1963, Statistics for Psychologists, New York: Holt, Rinehart and Winston.
- Hills, J. R., 1964, "Prediction of College Grades for all Public Colleges of a State," Journal of Educational Measurement, 1, 155-159.
- Hoyt, D. P. and Norman, W. T., 1954, "Adjustment and Academic Predictability," Journal of Counselling Psychology, 2, 96-99.
- Jacobs, J. B., 1959, "Aptitude and Achievement Measures in Predicting High School Academic Success," Personnel and Guidance Journal, 37, 334-341.
- Juola, Arvo E., 1963, "Freshmen Level Ability Tests and Long-range Prediction." Paper presented to the National for Measurements in Education, February, 1963.
- Katz, I., 1964, "Review of Evidence Relating to Effects of Desegregation on the Intellectual Performance of Negroes," American Psychology, 19, 381-399.
- Knoell, D. M., 1961, Inter-institutional Studies Leading to Changes in Freshmen Admission Requirements, AERA Paper, California State Department of Education, Mimeographed 12 p.

- Griffith, Edwin E., 1960, "The Prediction of Predictability," Educational and Psychological Measurement, 20, 3-8.
- Griffith, Robert W. and Hansen, James C., 1970, "Relationship of SAT Scores to College Achievement and Adjustment," Journal of College Student Personnel, 11, 129-135.
- Green, Robert L. and Farquhar, William W., 1965, "Negro Academic Motivation and Scholastic Achievement," Journal of Educational Psychology, 56, 241-243.
- Green, Robert L., 1965, "The Black Quest for Higher Education: An Academic Dilemma," Personnel and Guidance Journal, 43, 902-911.
- Hartnett, Rodney T., 1964, "An Analysis of Factors Associated with Changes in Scholastic Performance Patterns," Unpublished Doctoral Dissertation, Michigan State University.
- Hays, William L., 1964, Statistics for Psychologists, New York: Holt, Rinehart and Winston.
- Hills, J. R., 1964, "Prediction of College Grades for All Public Colleges of a State," Journal of Educational Measurement, 1, 1-129.
- Hoyt, D. P. and Norman, W. T., 1954, "Adjustment and Academic Predictability," Journal of Counseling Psychology, 2, 96-98.
- Jacobs, J. B., 1959, "Attitude and Achievement Measures in Predicting High School Academic Success," Personnel and Guidance Journal, 7, 334-341.
- Jones, Arvo E., 1963, "Freshman Level Ability Tests and Long-range Prediction," paper presented to the National for Measurements in Education, February, 1963.
- Katz, I., 1964, "Review of Evidence Relating to Effects of Desegregation on the Intellectual Performance of Negroes," American Psychology, 19, 381-382.
- Knoell, D. M., 1961, Inter-institutional Studies Leading to Changes in Freshman Admission Requirements, AERA Paper, California State Department of Education, mimeographed 13 p.

- Kowitz, G. T. and Armstrong, C. M., 1964, "Patterns of Academic Achievement," School and Society.
- Lavin, David E., 1965, The Prediction of Academic Performance: A Theoretical Analysis and Review of Research, Russel Sage Foundation, New York.
- Lehmann, Irvin J. and Dressel, Paul L., 1963, Critical Thinking, Attitudes and Values Associated with College Attendance. Cooperative Research Project No. 1646, Office of Education, U.S. Department of Health, Education and Welfare, East Lansing, Michigan State University.
- Li, Jerome C. R., 1964, Statistical Inference, Edwards Brothers, Inc., Ann Arbor, Michigan.
- Linn, R. L., 1966, "Grade Adjustments for Prediction of Academic Performance: A Review," Journal of Educational Measurement, 3, 313-329.
- Lunneborg, Clifford E. and Lunneborg, Patricia W., 1967, "Pattern Prediction of Academic Success," Educational and Psychological Measurement, 4, 945-953.
- Lutz, S. W. and Richards, J. M., 1968, "Predicting Student Accomplishment in College from the ACT Assessment," Journal of Educational Measurement, 5, 17-29.
- Malnig, L. A., 1964, "Anxiety and Academic Prediction," Journal of Counselling Psychology, 11, 72-75.
- McClelland, David C., 1958, "Issues in the Identification of Talent," In McClelland and Associates, Talent and Society, D. Van Nostrand Co., Inc., Princeton, N.J.
- McKelpin, J. P., 1965, "Some Implications of the Intellectual Characteristics of Freshmen Entering a Liberal Arts College," Journal of Educational Measurement, 2, 161-166.
- Moonan, William J. and Wolfe, John H., 1963, "Regression and Correlation," Review of Educational Research, 33, 501-509.
- Munday, Leo, 1965, "Predicting College Grades in Predominantly Negro Colleges," Journal of Educational Measurement, 2, 157-160.

- Kovitz, G. T. and Armstrong, G. W., 1964, "Patterns of Academic Achievement," School and Society.
- Lavin, David E., 1962, The Prediction of Academic Performance: A Theoretical Analysis and Review of Research, Russell Sage Foundation, New York.
- Lehmann, Irvin J. and Dressel, Paul L., 1963, Critical Thinking, Attitudes and Values Associated with College Attendance, Cooperative Research Project No. 1948, Office of Education, U.S. Department of Health, Education and Welfare, Lansing, Michigan State University.
- Li, Jerome C. R., 1964, Statistical Inference, Edwards Brothers, Inc., Ann Arbor, Michigan.
- Linn, R. L., 1966, "Tests Instruments for Prediction of Academic Performance: A Review," Journal of Educational Measurement, 3, 215-237.
- Linn, R. L. and Gage, N. L., 1967, "Patterns of Achievement in Academic Success," Educational and Psychological Measurement, 4, 925-933.
- Linn, R. L. and Gage, N. L., 1968, "Predicting Student Achievement from the ACT," Journal of Educational Measurement, 5, 17-29.
- Maining, L. A., 1964, "Anxiety and Academic Prediction," Journal of Counseling Psychology, 11, 72-75.
- McClelland, David C., 1958, "Issues in the Identification of Talent," in McClelland and Associates, Talent and Society, D. Van Nostrand Co., Inc., Princeton, N.J.
- McKelpin, J. F., 1965, "Some Implications of the Intellectual Characteristics of Freshmen Entering a Liberal Arts College," Journal of Educational Measurement, 2, 161-166.
- Moore, William J. and Wolfe, John H., 1963, "Regression and Correlation," Review of Educational Research, 33, 201-209.
- Munday, Leo, 1965, "Predicting College Grades in Freshman Year," Journal of Educational Measurement, 2, 157-160.

- Odell, C. W., 1927, "Attempt at Predicting Success in Freshmen Year at College," School and Society, 25, 702-706.
- Peterson, R. E., 1968, "Predictive Validity of a Brief Test of Academic Aptitude," Educational and Psychological Measurement, 28, 441-444.
- Pettigrew, T., 1964, "Negro American Intelligence: A New Look at an Old Controversy," Journal of Negro Education, 33, 6-25.
- Punch, Keith F., 1969, "Reducing the Number of Predictor Variables: Principal Dogmatism and School Organizational Structure," Journal of Experimental Education, 38, 76-80.
- Reyes, Richard and Clarke, Robert B., 1968, "Consistency as A Factor in Predicting Grades," Personnel and Guidance Journal, 47, 5-55.
- Sampel, David D., 1969, "A Comparison of Negro and White Students Using the SCAT in Predicting College Grades," Missouri University, Columbia, 1969.
- Saunders, D. R., 1956, "Moderator Variables in Prediction," Educational and Psychological Measurement, 16, 209-222.
- Seashore, H. G., 1962, "Women Are More Predictable than Men," Journal of Counselling Psychology, 9, 261-270.
- Segel, David, 1934, Prediction of Success in College, United States Department of Interior, Office of Education, Bulletin No. 18, Washington, Government Printing Office.
- Stanley, Julian C. and Porter, Andrew C., 1967, "Correlation of Scholastic Aptitude Test Score with College Grades for Negroes versus Whites," Journal of Educational Measurement, 4, 199-218.
- Thomas, Charles Leo and Stanley, Julian C., 1969, "Effectiveness of High School Grades for Predicting College Grades of Black Students: A Review and Discussion," Journal of Educational Measurement, 6, 203-215.

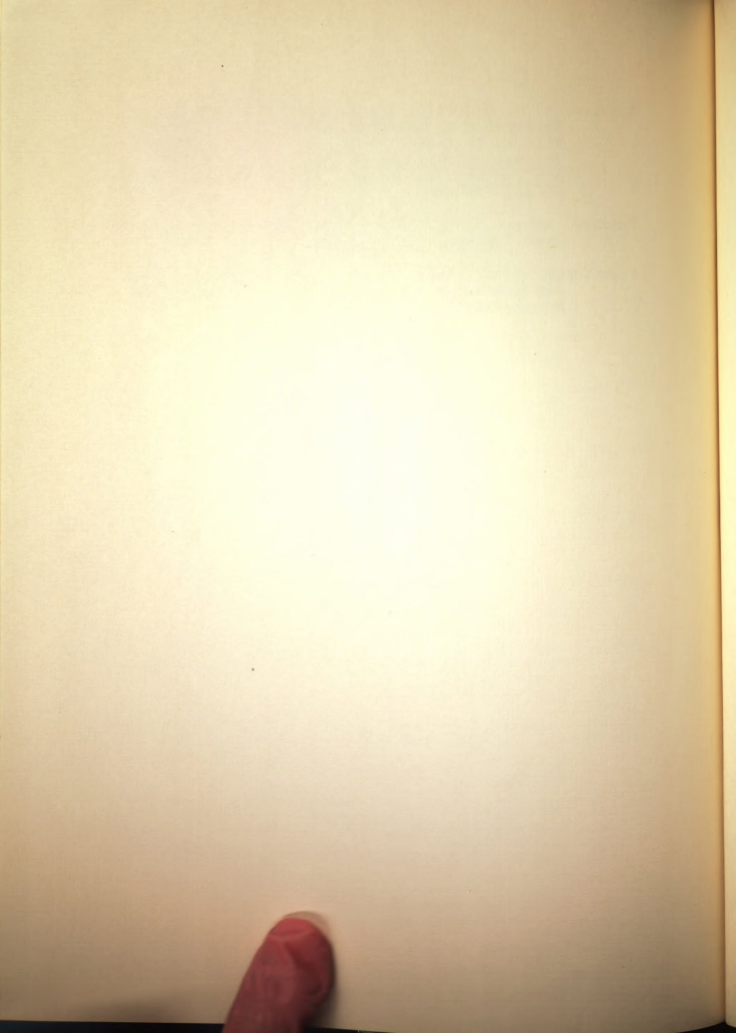
- Odell, C. W., 1937, "Attempts at Predicting Success in Freshman Year at College," School and Society, 25, 703-706.
- Peterson, R. E., 1968, "Predictive Validity of a Brief Test of Academic Aptitude," Educational and Psychological Measurement, 28, 441-444.
- Peterson, T., 1964, "Negro American Intelligence: A New Look at an Old Controversy," Journal of Negro Education, 33, 6-35.
- Pugh, Keith F., 1969, "Reducing the Number of Predictors for Variability: Practical Doctrines and School Organizational Behavior," Journal of Experimental Educational, 25, 44-55.
- Reyes, Richard and Robert E., 1965, "Consistency as a Factor in Predicting Success," Personnel and Guidance Journal, 13, 1-5.
- Sampel, David D., 1965, "Predicting Success of Negro and White Students Using the Test of Academic Aptitude," Journal of Negro Education, 34, 1-5.
- Sandberg, D. E., 1965, "Predicting Success in Prediction," Educational and Psychological Measurement, 25, 109-117.
- Sandberg, H. G., 1965, "The Use of More Predictable than Men," Journal of Educational Psychology, 57, 121-130.
- Siegel, David, 1934, Prediction of Success in College, United States Department of Interior, Office of Education, Bulletin No. 18, Washington, Government Printing Office.
- Stanley, Julian C. and Porter, Andrew C., 1967, "Correlation of Scholastic Aptitude Test Scores with College Grades for Negroes versus Whites," Journal of Educational Measurement, 4, 193-218.
- Thomas, Charles Leo and Stanley, Julian C., 1968, "Effectiveness of High School Grades for Predicting College Grades of Black Students: A Review and Discussion," Journal of Educational Measurement, 5, 203-215.

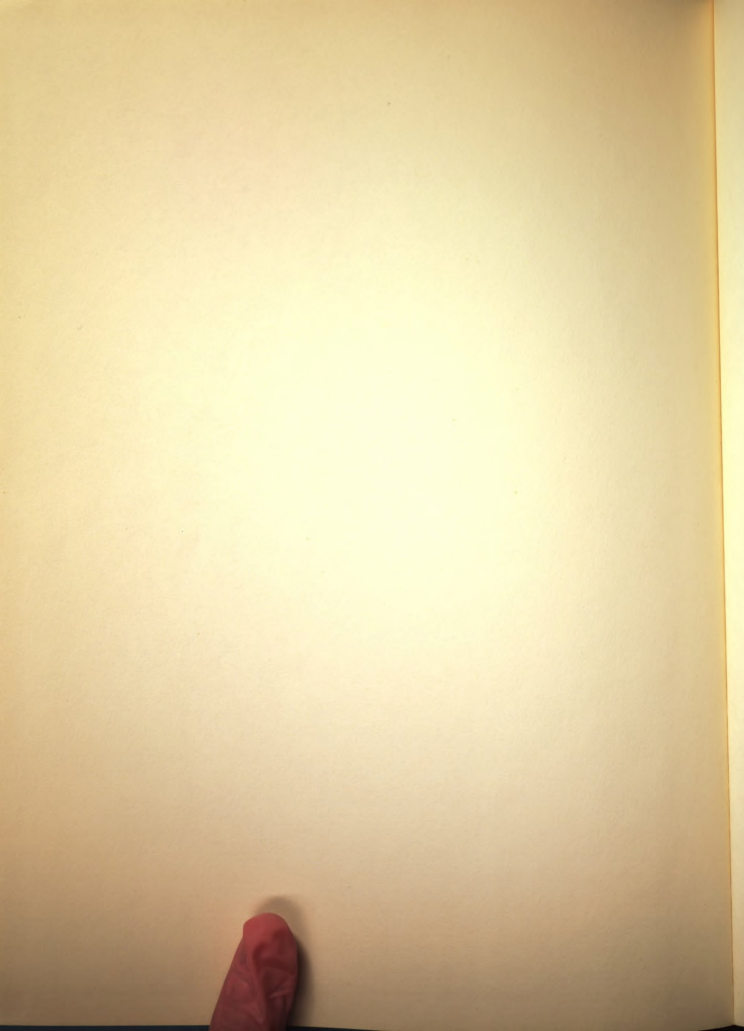
Travers, R. M. W., 1949, "Significant Research on the Prediction of Academic Success," In Donahue, William T; Coomb, C. H.; and Travers, R. M. W.; The Measurement and Student Adjustment and Achievement, Ann Arbor: University of Michigan Press, 147-190.

Travers, Robert M. W., 1959, "The Prediction of Achievement," School and Society, 7-, 293.

Trebilcock, W. E., 1938, "Many of the 'Lowest Third' of our Graduates Are College Material," Clearing House, 12, 544-546.

- Travers, R. W., 1942, "Significant Research on the Prediction of Academic Success," in Donahue, William T. Cook, C. H., and Travers, R. W.: The Measurement and Student Adjustment and Achievement, Ann Arbor: University of Michigan Press, 147-150.
- Travers, Robert M. W., 1929, "The Prediction of Achievement," School and Society, 7, 231.
- Tredlock, W. E., 1938, "Many of the 'lowest third' of our Graduates Are College Material," Cleaving House, 12, 244-246.







MICHIGAN STATE UNIVERSITY LIBRARIES



3 1293 03111 6183