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AN EXPLORATORY STUDY TO DETERMINE THE SIGNIFICANCE OF EARLY LONGITUDINAL RECORDS OF ABILITY AND ACHIEVEMENT AS PREDICTORS OF ACADEMIC ACHIEVEMENT IN COLLEGE

by
Carl Herbert Haag

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy in the
University of Michigan
1960

Doctoral Committee:

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"Quality and excellence in higher education in the colleges will continue to be associated with equality of opportunity for all who show promise of profiting from it, with the recognition of individual differences in students, and with diversity of educational programs designed to meet the interests, abilities, and needs of students as prospective citizens and productive members of a democratic society in a complex technological age--an age in which human beings are still our most important resource."

--H. D. Richardson
School and Society

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CHAPTER I

INTRODUCTION

Child development, as a field of study, is in its infancy. The great upsurge of interest in this area, now called developmental psychology, began in America in the 1920's. This was the era when Terman began his study of 1,000 gifted children (82), when the National Research Council formed the Committee of Child Development (62), when the Harvard Growth Study (18) was initiated, and when Gesell published his work on the behavioral development of children (31).

Elsewhere, interest in the systematic study of growth of children was also strong. Many universities, including Iowa (5), Chicago, Minnesota (43), California (6), Columbia, and Michigan (65), instituted programs of one kind or another. In addition, special schools and institutes were founded--Merrill-Palmer in Detroit (80) and Fels Institute in Yellow Springs, Ohio (77) being two of the outstanding ones.

Characteristic of all of the above programs was the strong empirical approach. To learn how children grow and develop it was necessary to measure various manifestations of these processes, and many methods of collecting these

data were developed or improved. These methods of collecting data are of three types: (1) physical measurements of body growth; (2) systematic observations of behavior where the stimulus field of the child is relatively free and unstructured, such as is found in play; and (3) response measurements where the stimuli are carefully controlled by the experimenter, as in tests and questionnaires.

One of the first needs of researchers in the area of child development was for normative data, information as to the characteristic development or behavior of children of a certain chronological age. Accordingly, cross-sectional studies were begun to determine how tall the average six year old was, whether the average nine year old could repeat 4 digits backwards, or whether the average child of twelve could define words like "skill," "juggler," and "brunette."

While normative data give a general, actuarial picture of typical attainments in growth and behavior, they do not specify the unique growth pattern of a single child and may even obscure it. Recognizing this, various researchers began collecting data on individual children as they grew over a period of years. This type of study, the longitudinal approach, has several advantages over the cross-sectional method, among them being the description of the process of change, an opportunity to study both parent-child and sibling resemblances, and the means to attempt multi-factor approaches to the study of the organism, embracing physical, mental, social, and emotional development (34).

Representative of the types of information gathered in longitudinal studies is that obtained by the child development laboratory of the University School at the University of Michigan. The data collected include such physical and mental measurements as: height, weight, number of permanent teeth erupted, extent of ossification of hand and wrist bones, strength of grip, mental age, reading, arithmetic, and spelling (65). Any particular child's status at any given time is of course determined from normative scales--the most familiar probably being the Stanford-Binet tests used to obtain mental age--, but over a period of time the individual's unique pattern of growth unfolds.

Through the study of children over a span of years, certain generalizations about the growth process have been made. Longitudinal records clearly show that a child grows in his own inimitable, but characteristic, way. Olson (63) has expressed this statement more fully in a summary of findings of the holistic approach to growth:

> Children differ in rate and level of growth. Growth through time is an individual matter. Children differ in the pattern of growth of the various components that are measured. . . . Children tend to attain the mature status of the species and the family at different ages. (63 - pp. 221-22)

In addition, there seems to be a certain unity in growth (64), and there are resemblances between members of the same family when patterns of growth are viewed (73).

Because of the temporal dimension of longitudinal studies the early years of such projects are restricted to data collection. Thereafter, reports of findings of a de-

scriptive nature are possible. As growth processes are identified and abstracted from the data, it is possible to utilize the information to make predictions of future growth and behavior since the best estimate of what will happen to a person in the future is what has happened to him in the past.

The applicability of child development data is nowhere more vital than in the educational setting, and much of the research in this area has attempted to determine how various behavior and growth samples at one period correspond to those of another--the latter often being performance in school. The bulk of the studies have concerned themselves with the correlation of a measurement at one point in time with another one later. In contrast, the utilization of longitudinal records has been rare.

In one of the few studies to use longitudinal data Whaley found confirmation for the hypothesis that "fast growers in elementary school will receive better grades in high school" (93 - p. 75), although status scores were also substantially related to high school achievement. The importance of this finding stems from the fact that while two children in the latter grades of elementary school may have similar intelligence and achievement test results, the fast growing child is likely to do better than the average or slow growing child in his secondary school work. Even more important, the child of less than average ability who is fast growing may well surpass children of apparently greater

ability. Such a child might be easily overlooked as a candidate for college preparatory classes.

The Research Problem

Making predictions of future performance by using longitudinal records is based on the premise that growth characteristics of an individual determined over a period of years will continue in the same direction, for instance that a fast grower will continue to be a fast grower. If this is true, the achievement of individuals over longer periods of time--even at the college level--might be predictable. It was with this thought in mind that a decision was made to explore the use of longitudinal growth data, obtainable at the University School of the University of Michigan, to determine what relationships might be found between early growth patterns and college achievement as indicated by grade point average.

While many aspects of growth might be included in such a study, it was decided to analyze two factors which would likely bear the greatest relationship to college achievement (81, 23). These two factors are: mental age (MA) which is measured by the Stanford-Binet Intelligence Test and the educational age (EA) which is the mean of all the sub-scores of the Stanford Achievement Test. The MA and EA growth data would be secured for children who had attended the University Elementary School between the years of 1930 and 1945 and who had gone on to college.

Among the growth characteristics which could be

related to College Grade Point Average (CGPA) are: the rate of growth indexes for MA and EA and how early or late growth in each of these areas began. Another variable which might be critical in predicting college achievement is the discrepancy between the EA and the MA growth indexes. Ketcham (47) has cited some cases where the rapprochement between EA and MA did not take place until late in adolescence which seemed to lead to academic problems in the first semesters of college work.

Of course, it would also be necessary to determine whether longitudinal growth measures were truly more effective than the usual status scores in predicting future achievement. This can be accomplished by using the latest mental and achievement scores available for each child.

At a basic level this study becomes involved with one of the most perplexing problems in psychology: the variability found in humans. The variability found between people is widely known, but Hughes (42) has pointed out that variability also exists within a person and it is this, incidently, which establishes his essential uniqueness. The importance of variability cannot be underscored enough. On the one hand it leads to much of the difficulty that is found in making predictions of future performance--the number of factors, and their relationships, which must be considered are prodigious. On the other hand, the acceptance of human variability or lack thereof leads to certain decisions involving selection of students for college and the

types of educational experiences they receive once they are enrolled. Many college officials seem to direct their activities towards attracting and educating only the most outstanding students, but as Ketcham (46) has pointed out the increase in college enrollments will come largely from the ranks of the intellectually average and superior students.

Before specifying the hypotheses to be tested, the characteristics of the group studied, and the procedures used, it is perhaps advisable to provide more background on some of the problems associated with admission to American colleges. It should be kept in mind that many forces influence college admission practices, and while the ubiquitous nature of these forces might tend to obscure their effect, it is probable that they color the perception of test scores, the view of college programs, and even how the students themselves are seen. The next chapter will discuss some of these forces and their effect on college attendance.

CHAPTER II

ADMISSION TO COLLEGE

The American College Scene

Opening fall enrollments in institutions of higher education reached an all-time peak of 3,402,297 degree-seeking students in the academic year of 1959-1960 (90). This total reflected a 4% increase over the 1958-1959 enrollment figures and was the eighth consecutive year that the figures had risen (90). However, these record enrollment figures are only a mild ground swell compared to the on-rushing tidal wave of students in the future.

To properly evaluate the growing enrollments in colleges and universities and to make predictions for the future, it is necessary to understand the factors underlying the boom in college attendance. The two major contributing factors are: the increasing birth rate and the increasing percentage of college age youths actually attending institutions of higher education.

The number of births in the United States was maintained at a fairly stable figure of a little more than two million between 1933 and 1939 (84). In 1940 the birth rate started a spectacular rise which continued through the post-war years until in 1953 it was practically double the figure

for 1933 (84). Since 1953 the birth rate has been at a plateau of slightly over 4 million births per year, a figure which promises no future relief for strained facilities (88).

The above expressions of our national fecundity have rather obvious implications for educators. Increases in the birth rate can be directly translated into more classrooms, more teachers, more money. These problems have already been faced by elementary and secondary school administrators. With the impending high school graduation of the first group of "war babies," college administrators are faced with similar problems of increasing demands--a situation reminiscent of the postwar bulge of veterans but potentially much more crushing.

In addition to the "baby boom" there is another factor which indicates mushrooming college enrollments: the increasing percentage of students going on to college. At the turn of the century only 4% of the college-age youths--more precisely, the total number enrolled in college compared to the total number of 18 to 21 year olds in the population --were enrolled in colleges and universities (67). By 1940 this percentage had increased to 15.6% (67). Determining the comparable 1950 percentage is made difficult by the veteran backlog causing swollen college enrollments; however, Millett (57) has estimated the non-veteran college population to represent 20% of the total 18-21 year old group in that year. In a careful study of the Greater Cleveland area White (94) found that 20.7% of the total number of 18 year olds from the

seven-county area surveyed enrolled in college.

Since 1950 the percentage of non-veteran, resident students compared to the 18-21 year old population has continued to climb--being 21.8% in 1951-52, 25.9% in 1953-54, and 29.0% in 1955-56 (89). The steady progression has continued in the last two years. For 1958 the comparable ratio is 35.6% (37) and for 1959 it is 38%.[1] Whether this increase in attendance will continue is impossible to determine at present.

Behind the increasing ratio of college attendance lie some related data which illustrate the increasing retention power of the public schools. The latest available information (25 - pp. 20-1) which compares fifth grade classes for the years 1924-25 and fifth grade classes for 1948-49 is as follows:

For every 5th grader in school:	1924-25	1948-49
The percentage entering high school was	61.2%	86.3%
The percentage graduating from high school was	30.2	58.1
The percentage entering college was.	11.8	30.1

The above figures represent a 41% increase in the rate of students entering high school, a 92% increase in the rate of graduating from high school, and a 155% increase in their

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[1]The figure for the 1959-60 academic year was arrived at by dividing the total number in the 18-21 year old population as of July 1, 1959 (87) into the figure for the opening fall enrollments for 1959 (90). It should be noted that this last figure includes students of all ages, both graduate and undergraduate, full-time and part-time.

rate of entering college (25). As many students are now gaining admission to college as formerly graduated from high school alone!

Making a forecast of future college enrollments is risky. While birth rate statistics can be projected ahead with some confidence, it is not possible to determine what percentage of the college-age group will seek post-high school education. The most conservative estimate which has been made, based on the current proportion of college-age enrollees and on birth statistics, was that by 1967-68 over 4 million students would be in college (84). Other estimates are even more impressive--Robert Gordon Sproul suggested that college enrollments will be 4.5 million by 1965 (79), the editors of Clearing House estimate 5 million by 1965-66 (13), and the President's Committee on Education Beyond the High School feels that by 1970 there will be 6 million students in college (68).[2] Various indications suggest that the number may be well over this, and it is not unlikely that within the next 7 years there will be a million more students in attendance at American colleges and universities than there are now.

Problems of the College Crush

While exact predictions of enrollment figures lack

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[2]Variations in the estimates of future enrollments might be caused by several factors--how well-informed and careful an analysis was made, the percentage figure of college enrollees to college age youth used, and how broadly college education is viewed, i.e. whether it includes all education beyond the high school.

precision, it is safe to assume that college facilities will be strained by an avalanche of students. Many of the problems faced by college administrators, boards of trustees, and both state and national officials are apparent--even though the answers may not be. They all revolve around the question: how shall we educate these students?

Decisions in this area involving the expansion of college facilities would be difficult enough if buildings, equipment, finances, and staffing were the only problems. However, decisions on these issues are predicated on underlying beliefs about the role of higher education in America, and there is a remarkable lack of concordance in these beliefs, even among specialists.

The range of beliefs as to who and how many should go to college is extensive. At one extreme is Harris (35) who believes that the increasing numbers of college graduates will far exceed the supply of professional and prestige jobs. The effect of not being employed in positions befitting their education could lead to serious consequences, Harris feels, perhaps resulting in a reaction of frustration tantamount to that in post World War I Germany which Kotschnig (51) suggests was partially responsible for the social unrest, disillusionment, and discrediting of intellectual effort.

At the other extreme are the recommendations of the President's Commission on Higher Education. Far from suggesting that enrollments be curtailed or cut-back, the Commission stated that tests of general ability indicate that 49%

of our population has the mental capability to complete 14 years of schooling and that 32% of the population has the ability to complete "an advanced liberal or specialized professional education" (67 - p. 41).

Without delving into the social ideologies or educational philosophies which are expressed in the various roles seen for higher education, it can be suggested that the major emphasis of those who have examined the problems in higher education since 1950 has been greater concern for untapped talent than with a surfeit of college graduates (57, 68, 95). The glaring discrepancy between able, potential college students and those who actually continue their education past high school can be gleaned from figures indicating that of those students with the highest capabilities--those scoring 130 or above on the AGCT test--, only 53% enter college and only 46% of the total number of 152,000 ever graduate (95). Even this record appears striking when compared to the figures for the top 25% of eighteen-year-olds ability-wise of whom only 40% enter college and barely more than half of these ever receive the bachelor's degree (57).

It should be noted that certain sub-groups account for a disproportionate number of those with ability who either do not attend college or fail to complete the program. Among these sub-groups are children of nonprofessional parents, women, minority groups, those living at a distance from the closest college, and youths from low income parents (68). One authority (57) ranks low motivation as one of the primary

reasons that capable students decide not to continue their education.

Attrition of college students is a vexying problem, particularly in times of heavy college applications. It often results in bulging freshmen classes and sparse upper-class enrollments. In a careful study of periods of attendance in college Iffert (91) found the following rates of attrition in American institutions: 11% did not register for the second semester, an additional 17% did not return the second year, and another 15% did not complete more than two years of college. In total, only 40% of the students who entered college in the Fall 1950 class graduated at the end of four years.

The American college scene has been examined, both as to its qualitative and its quantitative aspects. The problems raised by the increasing numbers desiring admission to college and by the still untapped resources of talent both focus on a common need: the need to better understand those students who have the ability to do college work.

Better Articulation Between High School and College

Many groups and organizations are interested in bettering the articulation between high school and college and in improving the survival chances of those who do continue their education after high school. Among these organizations are the American Association of Collegiate Registrars and Admissions Officers, the American Association of Junior Colleges, the American Council on Education, the Association

of College Admissions Counselors, the Association for Higher Education of the NEA, the College Entrance Examination Board, the Educational Records Bureau, the Educational Testing Service, and the various regional Associations of Colleges and Secondary Schools (2). Some of these organizations have been active in this area for several decades.

Recently, the problems of meeting the educational needs of our youth and our country have been removed from the bailiwick of the professional organization and given wide circulation in the daily newspapers. Unfortunately, much of the publicity has been associated with our competitive situation with Russia. We have been told that "they" are training more engineers and technicians than we are, thus accounting for their achievements in rocketry and strongly suggesting we should start crash programs in the technical area. Such stories only obscure the real problems we face--our principal task in education being, according to George Counts, "The rearing of a generation of citizens who will be able to rise to the moral and intellectual challenges of these fateful times" (16 - p. 8).

Not only is the general populace more alert to the problems of higher education--"better informed" would be an unwarranted aphorism--because of the mass media, but many families have experienced the growing concern in the area of college admissions through such manifestations as "college days," CEEB tests, multiple applications.

Nor are parents alone in their increased interest in

higher education. The federal government, which has always had ambivalent attitudes about supporting higher education, has recently passed the National Defense Education Act which, this year, is spending $150 million to bolster education at all levels, from the elementary school through to the college level (19). While a great deal of this money is designated for the upgrading of science, mathematics, and foreign language study, $7.4 million is earmarked for improving testing and counseling programs, which in turn is expected to help in better guidance for pre-college students (19). In fact, Section 101 of the Act specifically mentions, "We must increase our efforts to identify and educate more of the talent of our Nation" (61 - p. 114).

Interest in the concerns of higher education by the lay public, professional organizations, and the national government is commendable. Ultimately, however, the solution of admission problems at the college level rests upon our ability to recognize students who are able to take advantage of post-high school education and to guide them in choosing what for them will be the most fruitful college environments and programs. In other words, the fundamental need is for the extension of our knowledge of human nature which in turn rests on a foundation of basic research supported by empirical data. Specifically, the goal is even more pointed: to make predictions as to which students will succeed at which colleges.

The American Ideal

Before scrutinizing the various means employed to predict a student's success in college, it is important to understand some of the factors which directly, or at least tangentially, affect college attendance. These factors are intimately involved with the American culture and with the unique development of colleges and universities in this country.

In no other country in the world have the doors to higher education been opened to more students than in the United States. In no other country has there been such a proliferation of types of institutional or program offerings as in this country. Even today, with certain exceptions, higher education elsewhere is education for only a small minority, usually from 4% to 10% of the population. This is true in Asia, South America, Europe, including England, and even in the British Commonwealth nations such as Australia and New Zealand, where Oxford and Cambridge trained professors resist attempts to admit more than 5% to 8% of the high school graduates (85). It has been observed, also, that this attitude "exerts a determining influence on university curricula. Education is conceived primarily as mental discipline, training the mind to think logically" (85 - p. 160). America it should be noted, is not without its advocates of training for the intellectual elite!

American opinion has generally rejected the idea of educating only the intellectually superior and has supported

the attitude trenchantly stated by Robert Gordon Sproul, former President of the University of California,

> Nor is relief to be found in the setting of standards of admission that will eliminate the overwhelming majority of young people, as is the practice in most of the rest of the world. The development of American education has been motivated from the beginning, and increasingly throughout our history, by respect for all honest vocations and all useful labor, and by a desire to provide for equality of opportunity for all youth (1 - p. 99).

American higher education has been shaped and molded by many forces. The early American colleges such as Harvard, William and Mary, Yale, Princeton, were patterned along the line of the English universities. This remained the dominant character of higher education until the 19th Century when state universities were begun, many blossoming as a result of the Morrill Act of 1862. During this same mid-century period, American educators, including President Tappan of the University of Michigan, returned from Germany and instituted ideas that ran counter to the English <u>in loco parentis</u> philosophy which then predominated in the United States (22).

The English College and German University seeds of education planted in the soil of the New World resulted in a hybridization of institutions which is unparalleled. The American sense of the practical resulted in college courses frankly vocational in nature. Science, engineering, agriculture, and many other courses came into being. Concomitant with the introduction of vocational courses was the introduction of the elective system which had its first birth pangs at Harvard in 1825 but did not reach its full majority until

the presidency of Charles William Eliot in 1869 (27). With the new freedom of choice offered to students plus rapid expansion of knowledge, courses proliferated.

Another factor exerting an influence on the policies and practices of American colleges was the admission of women. Coeducation, begun at Oberlin in 1838 and Antioch in 1853, rapidly spread to the state universities and land-grant colleges (32).

Thus, from many sources and in many ways the contemporary philosophy of higher education in America has developed and evolved. This philosophy is consistent with democratic ideals, as de Kiewiet points out, ". . . we are committed to provide opportunity for education to all, regardless of economic status, race, color, national origin, creed, or religion" (27 - p. 269). The dominant issue, therefore, is to provide "the kind of education that makes it possible for each individual to become all that he is capable of becoming" (69 - p. 456). This objective in higher education has received strong endorsement from The President's Commission on Higher Education and from The President's Committee on Education Beyond the High School.

The American ideal in higher education, when translated into purposes and programs of institutions takes many forms. Fretwell has summed up his view of the American college scene using the term "diversity" (27 - p. 259). And a diverse picture it is. There are junior and community colleges, 4-year liberal arts colleges, technical institutions,

teachers' colleges, and universities. Some are private, some public, some church-related (38). All the foregoing types of institutions have distinct--characteristics which enable them to serve unique functions in a pattern found nowhere else.

Attendant with higher education for the many, therefore, is a diversification of institutions found in no other country. Such diversity allows an unparalleled freedom of choice for those wishing to further their education beyond secondary schooling. But this same diversity, coupled with expanded high school programs, makes articulation between these two levels of institutions more difficult than in days gone by when a prescribed educational program was followed throughout one's education.

While America has made strides in providing education for more and more persons, it should be apparent that there is still untapped potential. Some of the roadblocks to a fuller realization of providing the best education for citizens of all ages have been mentioned. One other, more pervasive and more subtle, was touched upon in Chapter 1: the variability found both within and between people. If this variability is not taken into account--as it is not when education provides uniform experiences for groups of dissimilar students--, the consequence is another block to full development of the individual. It was this that Ketcham had in mind when he stated, "In our democratic society practices which limit opportunities for secondary and higher education

cannot be tolerated" (46 - p. 173) and went on to urge greater understanding of individual differences and their implications for education. This, then, is an important aspect of the American belief in equality of opportunity for if human variability is not recognized and provision for these differences is not made the individual is effectively barred from the fullest utilization of his resources.

Faced with such a heterogeneity of students and institutions, with their varied purposes and capacities, the deceptively simple question posed by Hollinshead, "Who ought to go to what college, if he should go at all?" (28 - p. 5) is again raised. Certainly, part of the answer lies in the pre-college education and guidance provided for students, a point underscored by Dr. James Conant's statement that ". . . really effective counseling is the keystone of the arch of a widespread educational system dedicated to the principle of equality of opportunity" (18 - pp. 204-205).

The problem of articulation between high school and college is of concern not only to the pre-college counselor but also to the admissions personnel of the college. Besides the shared concern both groups have for the success of the students at college, the admissions officials have a more basic problem: how best might they fulfill institutional objectives through admissions policy?

Any admissions officer must attempt to solve the same problems raised in conjunction to higher education in general. For instance, he must make decisions as to the overall compo-

sition of the student body--how diverse it should be and what factors of diversity should be taken into account: level of ability, differences in interest patterns, male-female ratio, geographic distribution, socio-economic background, etc. Seldom are such decisions based on experimental findings which would indicate the actual effects the above variables have on the character of the institution. More often the operational policy of admissions officers is the resultant of objectives and beliefs on the one hand and on the other of such realities as limitations of plant, travel budgets, and the available pool of students who might apply to the college.

Just in terms of the ability dimension college officials might ask such questions as: what range of ability would be best, should an attempt be made to garner just the top students or should a certain segment of the ability pie be taken, how much effect does motivation have on performance and how can it be measured, and what effect do other personality variables have on college success?

It is evident, however, that many of the decisions in this area are contingent on the willingness and capability of the colleges to specify their institutional aims and to identify the types of students who might most profitably associate themselves with the program being offered. As was suggested earlier the bedrock for the foundations of pre-college guidance as well as college admissions is scientific knowledge. It is time to turn our attention to studies bearing on the issues raised.

CHAPTER III

PREDICTING COLLEGE SUCCESS

College admission procedures have changed radically from the individual oral examinations in Latin and Greek formerly used by Harvard, William and Mary, Yale, Princeton, Columbia, and other institutions established in the era up to 1750 (86). A brief survey of the past will provide a perspective for the current methods of predicting success in college.

The Search for Predictors of College Success

History - From their earliest beginnings in the American colonies, colleges have used various criteria to select students. However, before the turn of the last century these evaluative efforts might best be described as local and subjective. This does not mean that institutions were not interested in appraising their admissions procedures. As early as 1880 a committee at the University of Michigan found that for the previous nine years students admitted by certificate did better than those admitted by examination (56). However, the day of standardized tests, armies of high school counselors and college admissions officials, wide-spread use of statistical procedures, and national organizations interested in college testing pro-

grams did not develop until after the twentieth century was well under way.

The factors leading to increasing interest and precision in predicting college success are legion. Doubtlessly one of the greatest contributing factors was the testing movement initiated by Binet and others in Europe and furthered by Thorndike, Spearman, Terman, and others in America. By 1924 considerable work had been done on the use of tests to predict college performance. In that year one of the first journal articles appeared summarizing the results of a number of studies. It was reported that correlations between examinations and college grades ranged from .25 to .62 with a median of .46 (56).

Contemporary Scene - Methodologically the attempt to predict success in college remains unchanged. Samples of behavior prior to college are obtained and evaluated in light of performance in college. What has changed is the interest in the area, as reflected by the sheer number of journal articles, and the refinement of techniques and variables.

Both single predictors, such as tests or high school grades, and combinations of variables have been used to predict college achievement, which is almost invariably measured by grade point average. A survey of studies in this area will illustrate the relationships which have been found.

High school grade point averages have usually been found to be the best single predictors of college achievement, with correlations ranging from .50 to .65 (15). Grades in

some subjects, for example physical education, health education, and crafts seem to have little or no relationship with college performance and might profitably be excluded from correlation studies (15). More recently rank in class has been used as the basis for college admissions (2) and results yield correlation coefficients similar to those found for high school GPA's--.50 to .60 (15). It is usually preferable to make an adjustment for the size of the class and type of program when rank is used.

Much effort has been put into studies using standardized tests. Results have varied. At Staunton Military Academy neither the Otis Test of Mental Ability nor the American Council on Education Scholastic Aptitude Test (ACE) correlated higher than an $\underline{r}$ of .17 with first year achievement in college (9). This may be due to initially high selectivity at the Academy. It was found in the Eight-Year Study, involving 1,475 students in 160 institutions, that the correlation for the ACE and the four year grade point average in college was .40--the Iowa Silent Reading Test being almost as high, having a .35 correlation between it and CGPA (12). Most studies report slightly higher coefficients of correlation, although few are as high as .60 (15).

Fricke's (29) tabulation of the coefficients of correlation between various predictors and college achievement are presented in Table 1.

Several observations can be made from these data. First, most of the measurements used as predictors were proba-

TABLE 1

MEDIAN CORRELATIONS OF STUDIES OF VARIOUS PREDICTORS AND COLLEGE ACHIEVEMENT[a]

Predictor	No. of r's	Correlation with CGPA (Median r)
H.S. %ile Rank	5	.58
Avg. H. S. Grade	18	.54
Gen. Achievement Tests	7	.54
Mental Ability Tests	11	.45
ACE - Total Score	16	.43
SAT - Verbal	10	.43
SAT - Math	10	.34

[a]From Fricke (29)

bly made during the later secondary school years. Second, while all the coefficients are positive, they do not account for a large amount of the variance in college achievement. Third, although many of these measures were taken at a point-in-time of the person's life, it is perhaps significant that the highest ranking single predictors are based on data gathered over a period of time, i.e. grades throughout the four years of high school.

Still other devices have been used in attempts to predict college achievement. Teachers' ratings have proven to be of some value (9). So, too, have specific high school courses when compared to specific ones in college, although at times the relationships seem illogical--e.g. foreign language in high school correlating highest with animal husbandry in college (4). Although these indexes have shown positive relationships with college achievement, they have not been as

high as those where high school grades or ability test results were used.

As might be expected, multiple correlations involving several factors generally bear a higher relationship to CGPA than single predictors. Most often the factors used are high school grade averages and intelligence tests--the resulting correlations ranging from .56 to .71 (15).[1] Fricke (29) found the median of 27 studies using multiple correlation coefficients to be .63, while Donahue et al (20) reported a median of .69 on the basis of 12 studies using multiple factors.

Thus, substantial correlations have been found by using several factors, particularly those factors which have been obtained in the period just prior to college attendance. There is some doubt whether higher correlations are possible or even desirable. As MacPhail (56) has pointed out college students are a homogeneous group--the range of their intelligence test scores being half of the usual range--, and this reduces the possible correlation, making r's in the .80's and .90's unlikely. Fricke (29) has arrived at the same conclu-

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[1]The fact that higher correlations result when these two aspects of performance are combined suggests they are measuring different elements--perhaps akin to the problem of low and high levels of achievement to be discussed later--and it is more than likely that the elusive element variously called drive, motivation, interest, etc. may be a key factor. It could be entertained, for instance, that whereas maximal motivation can generally be elicited in a one-to-one testing relationship such motivation might be exhibited considerably less in class performance. This would suggest that the difference between ability (or aptitude) and achievement is largely a difference in the strength of motivation.

sion in a different manner: since the best predictor of CGPA beyond the first semester is the first semester's GPA--the r between them is .80--, other predictors cannot possibly come this high and therefore should be used only to predict the first semester GPA. While this latter conclusion could be altered by new evidence, it is probably safe to conclude that further refinements of measurement procedures will yield but little improvement.

Of greater concern now is making long-range predictions of college success. Donahue et al state this view succinctly:

> Attempts to predict college success have been made too often at a time in the student's career when it is too late for him to make use of such predictions. . . . If college success could be predicted early in a child's development then much could be done to provide him with the necessary background for college, and even more important, it would be possible to provide a well-planned secondary school curiculum (sic) for those who have little aptitude for college work (20 - p. 153).

The "too late" label obviously befits tests given to college freshmen, but it is also appropriate for the various tests which can be utilized during senior high school.

Making earlier predictions of college success would seem important, but how much research has been done in this area? The answer is: very little! Only a few studies have been concerned with the problem. Secondly, the studies that have been done have generally reported low or moderate correlations--between intelligence quotients in the first grade and honor point ratio in college (r = .21) between intelligence quotients measured before the age of fifteen and CGPA

(r = .35), between intelligence test results obtained in the ninth grade and college grades (r = .48), and between the National Intelligence Test given some time between the third and eighth grades and the first semester grades in college (r = .45) (20).

Intelligence quotients obtained before the ninth grade have not proven very valuable for predicting CGPA. Several researchers (58) have suggested that the most promising way of predicting an individual's academic work in the future is to use the individual's growth curves, and concluded by stating "the extent to which individual growth curves can be projected for prognosis is gradually being explored" (58 - p. 875). This is a definitive statement of the central task of this study.

CHAPTER IV

THE DESIGN OF THE STUDY

This chapter will contain a statement of the hypotheses to be tested, a description of the subjects, and a list of the measures and their statistical treatment.

Hypotheses

The major hypothesis is: While students with a wide range of abilities and educational achievements prior to college will be successful in college, it will be possible by using growth data to tell more accurately who will be successful, how successful they will be, and perhaps even what their achievement pattern in college will be like. More specifically, the hypotheses to be tested are:

A. The index number representing the slope of the Educational Age line will correlate positively with Grade Point Average earned in college.

B. The index number representing the slope of the Mental Age line will correlate positively with CGPA.

C. The Y intercepts of both the EA and MA variables will correlate with CGPA.

D. Increasing differences between EA and MA index numbers will vary inversely with CGPA.

E. Scores on single tests at any given point will not correlate as highly with CGPA as will rate of growth index numbers.

Subjects

The subjects used in this study attended the University Elementary School of the University of Michigan for at least part of their primary education--the minimum time in attendance being determined by the availability of at least three measures of EA and/or MA for each individual. In addition, it was necessary to obtain the college achievement record of each person which meant that only those who had already graduated from high school and were known to be or to have been in attendance at college could be used. Incompleteness of data, unusual methods of grading students in college, and other factors further limited the size of the group.

The final group of individuals who could be used in the study were born between the years of 1925 and 1941 (see Appendix A), and graduated from high school in the decade and a half between 1943 and 1958. When the subjects were divided into sub-groups according to sex and college of first attendance, the size of the various groups was as follows:

	Number
Girls who attended the University of Michigan	28
Girls who attended other colleges	20
Boys who attended the University of Michigan	33
Boys who attended other colleges	16
Total	97

This group of students is not representative of high school graduates generally. The range of intelligence quotients for one senior class at the University School was 54 to 163. The mean for the group was 116 (47). Since the

general ability of the students is higher than average, it is not surprising to find that approximately 83% of them matriculate in institutions of higher education. This is a far higher percentage than the current national average of 20% to 30+% mentioned in Chapter II.

Students at the University School are atypical also with regard to socio-economic status. On one evaluation it was found that 96% of the fathers of University School students are in the professional, semi-professional, and managerial categories as compared with 10% found in these categories for employed males in the nation as a whole (93).

Studies have shown a positive relationship of social class with intent to enter college (94) and with percentage of high school graduates who actually enter college (95). When intelligence scores are held constant it has been found that boys from the highest occupational groups are four times more likely to attend college than are boys from the lowest groups (67). The economic relationships involved are obvious, the attitudinal ones more obfuscated. It is possible, however, that the value systems held by those at the various social class levels will have an effect not only on attitudes about college attendance but also on the success the student achieves in college. In analyzing the results of this study the relatively limited range of socio-economic status of these students should be kept in mind.

The group involved in this study was even more select. Based on the last intelligence quotients available for these

students in elementary school, the average IQ's and the standard deviations (SD) were:

	Mean	SD
Girls who attended the University of Michigan	130	15
Girls who attended other colleges	121	19
Boys who attended the University of Michigan	126	17
Boys who attended other colleges	130	19

The level of the above means is high when compared with the mean of college students. One report places the average AGCT IQ of college students at 115 (95). The atypical character of University School students suggests two necessary conclusions: (1) any extrapolation from the results of this investigation should be done most cautiously, and (2) because the group is compressed into the top end of the ability scale the resultant correlations might be expected to be lower than in more normally distributed groups.

Independent and Dependent Variables

In this study the independent variables are educational age (EA) and mental age (MA) while the dependent variable is college grade point average (CGPA). How each of these measures was obtained and how the necessary calculations were made can now be examined.

EA is derived from the battery of tests which comprise the Stanford Achievement Test. The sub-tests include paragraph meaning, word meaning, spelling, language, arithmetic reasoning, and arithmetic computation. These sub-test scores are averaged and this average can then be given the appropriate age equivalent figure. This latter figure is the educa-

tional age. It was obtained every six months for most children in the study--the form of the test being changed at each administration and the level of the test being increased as necessary.

Mental age is similarly obtained. The mental age is found directly from the sub-tests of the Stanford-Binet Tests of Intelligence or from the Kuhlman-Binet which was used prior to 1942.[1] The intelligence quotient can be found by dividing the MA by the chronological age (CA) and multiplying the result by 100. An individual intelligence test was given to every child each year as close to his birthday as possible or at a point six months from his birthday if it occurred during the summer months.

The EA and MA data were collected by the Pupil Personnel Office of the University School and are on file there. For most students in this study records were available for a major portion of their elementary school years.

The EA and MA figures are statistically treated in two ways. One of these, the Rate of Growth Index, or slope of the growth line, indicates numerically how fast or slow a person is growing--a slope of +1.0 or 12 months of growth for 12 months of living being the mean rate. The graphic

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[1]Since it would have been impossible to have a sample of sufficient size using either test exclusively, the decision to combine both was dictated by necessity. In most cases the scores from only one of the tests was used in calculating the longitudinal statistics, the breakdown being: 50 records were from the S-B, 43 from the K-B, and 6 in which both had to be used. In testing the effect of using one test or the other in predicting CGPA, it was found that no significant difference existed between their correlations.

expression of such growth lines can be seen in Appendix B, where the chronological age is expressed along the abscissa of the graph and the growth age along the ordinate. The other measure is a figure representing the Y-Intercept which is a measure of earliness or lateness of growth and which is established by extending the growth line backwards--a negative extrapolation--to the intercept of the Y axis or ordinate. The formula for the method of least squares used to calculate the slope and Y-intercept for EA and MA is as follows:

$$a = \frac{N\Sigma XY - \Sigma X \Sigma Y}{N\Sigma X^2 - (\Sigma X)^2} \qquad b = \frac{\Sigma X^2 \Sigma Y - \Sigma XY \Sigma X}{N\Sigma X^2 - (\Sigma X)^2}$$

Where:

a = slope of the line (rate of growth over a period of time

b = Y- intercept of the growth line

X = CA in months

Y = either EA or MA in months

N = number of measures used

For each individual--except in a few cases where there were insufficient test results--four different independent variables were calculated:

EA Slope (or Rate of Growth Index)
MA Slope

Y-Intercept of EA
Y-Intercept of MA

College grade point average (CGPA), the dependent variable, was obtained from the institutions which the students attended. Each institution was asked to furnish the following information: first semester/quarter GPA, second

semester/quarter GPA, third quarter GPA, and the GPA at the time of graduation. They were also asked if the student was still enrolled, to indicate the honor point equivalents for each letter grade, and to submit the cumulative GPA for any students who left the institution before graduating.

As indicated previously more students attended the University of Michigan than any other institution. The distribution of students according to their college of first attendance can be found in Appendix C.

While divergent grading systems could be equated to that used by the University of Michigan (A = 4, B = 3, C = 2, D = 1, E = 0), other institutional differences, particularly that of original student selectivity, could not be so easily resolved. Therefore, students attending institutions other than the University of Michigan were put into a separate group.

In this study success in college has been operationally defined as CGPA. How adequate a measure of success CGPA is is open to question. However, it has been used for two reasons: (1) There is no other criterion for success, particularly one which can be treated statistically, which describes the achievement of all enrolled students, and (2) GPA is the factor most frequently used in determining whether students remain in college.

The design of the present study is to determine the relationship of EA and MA slopes and the Y-intercepts of EA and MA achieved in elementary school to CGPA. In the next chapter results of the analysis of the data will be presented.

CHAPTER V

ANALYSIS OF DATA AND RESULTS

The results of the study are presented in this chapter. The relationship between longitudinal growth factors and college performance will be investigated. In addition, the correlations between scores from single tests and college grade point average (CGPA) will be determined. The final section will be devoted to an analysis of the data for other findings germane to the study.

Results Related to the Hypotheses

Product-moment coefficients of correlation were calculated between first year CGPA and the various growth measures. The results are presented in Table 2. Correlation coefficients were obtained separately for each of four groups: women who attended the University of Michigan, women who went to other colleges, men who attended the University of Michigan, and men who attended other colleges. The above grouping makes it possible to control for the effect of sex or choice of college as related to college success.

First year college grade point average was used as the dependent variable for two reasons: (1) this figure was available for all of the students whereas the cumulative four year CGPA was not, and (2) it was found that for forty stu-

TABLE 2

CORRELATIONS OF FIRST YEAR GRADE POINT AVERAGE IN COLLEGE WITH LONGITUDINAL GROWTH FACTORS AND STATUS SCORES

Factors	Females			Men		
	U. of M. n = 28	Other n = 20	Total n = 48	U. of M. n = 33	Other n = 16	Total n = 49
First Year CGPA and:						
EA Slope	.40*	.27	.34*	.21	.52*	.38**
MA Slope	.60**	.22	.44**	.24	.37	.30*
EA Y-Intercept	-.07	.13		-.01	-.31	
MA Y-Intercept	-.46*	.10		-.16	-.10	
|EA - MA|	-.05	.20		-.20	.10	
EA - MA - 100	-.16	.20		-.01	.29	
|EA Y - MA Y|	-.06	.09		.30	.21	
EA Y - MA Y - 100	-.16	-.13		-.01	.19	
EQ at Age 11	.71**	.29	.53**	.25	.71**	.44**
Last IQ	.57**	.29	.44**	.39*	.60*	.47**

*Significant at the .05 level
**Significant at the .01 level

dents graduating from the University of Michigan their first year CGPA and four year CGPA correlated .92.[1] Since the relationship between first year grades and final CGPA has been a general finding (29), there was justification for using the first year CGPA as the dependent variable.

The data from Table 2 which are relevant to the original hypotheses will now be presented.

[1]This correlation is probably spuriously high since the four year CGPA contains the first year CGPA within it.

A. The index number representing the slope of the Educational Age line will correlate positively with Grade Point Average earned in college.

Hypothesis A is supported by the data since coefficients of correlation between EA slope and first year CGPA for the total groups of both male and female students are significant. A positive relationship also exists between the same variables for females who attended the University of Michigan and for males who attended other colleges.

B. The index number representing the slope of the Mental Age line will correlate positively with CGPA.

The above hypothesis is supported by the data. Significant correlations were found between the MA slope of the line and first year CGPA for the total groups of male and female students and for female students who attended the University of Michigan. The pattern is similar to that found between the EA slope and CGPA--a significant relationship existing between the independent and dependent variables for females who attended the University of Michigan but no significant relationship existing for females who attended other colleges and for males who attended the University of Michigan.

C. The Y-intercepts of both the EA and MA variables will correlate with CGPA.

Hypothesis C is not supported by the data since only one of the coefficients between the Y-intercepts of EA and MA and the CGPA is significant, the r of -.46. This solitary significant relationship might be associated with the r of .60 found for the same group of students between MA slope and CGPA.

This assumption appears warranted since a high negative relationship was found to exist between the slope of the line and the Y-intercept.

Originally it was postulated that the slope of the line and the Y-intercept were relatively independent so that the earliness or lateness of beginning growth and the rate at which it took place could be differentiated. Contrary to this expectation, when the EA slope and the EA Y-intercept, as well as the MA slope and MA Y-intercept, were correlated it was found the r's ranged from -.75 to -.90, with a median r of -.86. This indicates, at least statistically, a high, inverse relationship between the two factors. In turn, this lends support to the explanation for the significant correlation of -.46 mentioned above (and for the r of -.31 between EA Y-intercept and first year CGPA for males attending other colleges). Since Y-intercept correlates so highly with the slope and so poorly, if at all, with CGPA, doubt is raised as to its value as a factor.

D. Increasing differences between EA and MA variables will vary inversely with CGPA.

For this hypothesis the data were examined to determine whether differences between ability (MA) and achievement (EA) would bear any relationship to CGPA. This is related to the problem of underachievement and overachievement. The correlations of first year CGPA with |EA - MA|, EA - MA - 100, |EA Y - MA Y|, and MA Y - EA Y - 100 in Table 2 indicate that no significant relationship exists between these independent

variables and CGPA.

Some explanation should be made as to how the independent variables were obtained. It was found that the index numbers for EA slopes were generally larger than those for the MA slopes and that the same relationship held for EA Y-intercepts in relation to MA Y-intercepts. Therefore, the MA slopes and their Y-intercepts were subtracted from EA slopes and EA Y-intercepts respectively. For the few individuals where the reverse situation was true, the EA score was subtracted from that of the MA. In all cases the sign of the difference was ignored so that just the absolute difference between the two variables was used in the correlation.

A further step was taken. To obtain what in effect would be a rank order difference between EA and MA variables a constant figure, -100, was subtracted from the previously obtained differences but this time the sign of the difference was taken into account. While slightly different correlations were obtained with these two methods, none of them was significant.

E. <u>Scores on single tests at any given point will not correlate as highly with CGPA as will rate of growth index numbers</u>.

This hypothesis is obviously crucial in evaluating the importance of longitudinal measures. If scores on single tests correlate as highly with CGPA as do longitudinal growth measures there is little justification for undertaking the more complex calculations necessary to obtain slope and Y-intercept values. Correlations between single status scores

and CGPA were found to be at least as high as those between slope of the line and CGPA. Therefore, hypothesis E is not supported by the data.

The status scores used were the Educational Quotient (EQ), i.e. EA divided by CA times 100, and the Intelligence Quotient (IQ). The EQ was determined at approximately 132 months of age, while the IQ was the last one obtained in elementary school. In both instances the scores were among the latest available for the child and were obtained at approximately the sixth grade level.

Several approaches can be used to demonstrate the importance of single test scores of ability and achievement. First, nine of the twelve correlations between single test scores and CGPA are significantly high to indicate that it is unlikely they occurred by chance alone. In addition, those coefficients of correlation ranging from .53 to .71 account for between 25% and 50% of the variance and would be considered moderately high.

Secondly, correlations of EQ and IQ with CGPA can be compared to those between longitudinal growth measures and CGPA. In every case but two the correlations between CGPA and status scores are higher than those involving longitudinal measures--and of these two, the r's in one case are equal and in the other are only different by .03 points. Some of the differences in favor of the r's found for status scores might be large enough to be significant, but this cannot be determined since statistical tests of the significance of the

difference when the two r's are obtained from the same sample are not too satisfactory (30). However, the conclusion that status scores are as good as longitudinal growth measures in predicting CGPA six years in the future seems inescapable.

Thirdly, these results can be compared to the limited number of other studies in which variables obtained during the earlier grades were correlated with CGPA. Correlations between CGPA and various intelligence tests have been as follows: .21 for the Detroit Intelligence test given during the first grade (70), .37 for a test given in junior high school (7), and .45 for the National Intelligence Test given sometime between the fourth to eighth grades (11). In a more recent study of 772 children it was found that the Iowa Tests of Basic Skills taken in the sixth grade correlated .49 with their freshman year CGPA's (72). The r's obtained in this study between IQ and CGPA--correlations of .44 and .47 for the total groups of female and male students respectively --are comparable to those of the studies mentioned above. In another study (7) the Stanford Achievement test given at the junior high level was found to correlate .36 with CGPA, while the results found between the same variables in the present study, r's of .53 and .44, are higher but not significantly so.

The final indication of the importance of single test scores is found by comparing them to the median correlations between various predictors and college achievement that were listed in Table 1. The median r between general achievement

tests and CGPA in Table 1 was .54. The .53 correlation between EQ on the Stanford Achievement Test and CGPA found in this study for the total group of female students is very close to this figure, although the comparable correlation coefficient of .44 for male students is below it. However, in using the Stanford-Binet as a dependent variable both male students (r = .47) and female students (r = .44) closely approximate the median correlation of .45 found by Fricke (29) between mental ability tests and CGPA. It appears that the Stanford-Binet and Stanford Achievement test results obtained from University School children no later than the sixth grade correlate as highly with CGPA as the median of those found in other studies in which the tests were given at least several grades later and usually in the senior high years.

To summarize the findings relating to the original hypotheses: Both EA slopes and MA slopes were positively correlated with CGPA but were generally not as high as the coefficients between single test scores of EQ and IQ found in the sixth grade and CGPA; neither Y-intercepts nor differences between EA and MA index numbers correlated significantly with CGPA. There appeared to be differences between the sexes and differences between those students who went to the University of Michigan and those who went to other colleges.

Results of Multiple Correlations

All the relationships discussed thus far have dealt with single variables correlated with CGPA. Now combination of variables will be studied. The limited number of multiple

correlations which were calculated are presented in Table 3.

TABLE 3

MULTIPLE CORRELATIONS BETWEEN FIRST YEAR CGPA AND TWO OTHER VARIABLES

Factors	Women		Men	
	U. of M.	Other	U. of M.	Other
First Year CGPA and:				
EA Slope / MA Slope	.62		.42	
EA + MA / EA Y-MA Y-100	.66			
MA Slope / EA+MA			.42	
Last IQ / MA Slope	.60			
Last IQ / EA+MA Index			.39	
Last IQ / EA Y - MA Y			.57	
Last IQ / EA Y				.60
Last IQ / IQ - EQ	.71	.30	.40	.71
Last IQ / SD of IQ	.58		.53	
Last EQ / Last IQ	.71		.40	
Last EQ / IQ - EQ	.71			.72

Examination of Table 3 indicates that while the various combinations of factors give higher correlations with CGPA than do single factors (Table 2), only in two instances--both involving males who attended the University of Michigan--were the correlations above the highest r found between a single independent variable and CGPA. These results suggest that further manipulation of the variables would not result in a higher relationship with CGPA. It is not meant to suggest that combining several of these variables into a regression equation would be useless, but it does imply that a better

strategy would be to seek out other factors not related to the ability and achievement traits measured.

Additional Results

The extensiveness of the data gathered for this study makes further exploration possible. For example, because of the long-term nature of the testing program various questions can be raised about aspects of individual intelligence testing. How constant are IQ's? Which IQ score should be used: the average of all, the last one available, or the highest one? How early do intelligence test scores correlate significantly with later performance in college? Does variability of intelligence test scores over the years bear any relationship to college grades?

There are also other approaches to the prediction of success or failure at college. Differences between those students who fail their first year in college and those who get above a 3.0 average their first year can be analyzed. Quite pertinent to the study of individual differences is the question of whether significant changes in ability do occur after the elementary school period.

Another area which warrants consideration is the differences among colleges. Colleges, like individuals, do differ in their characteristics. Student populations from institution to institution vary greatly at least in terms of their ability level. The question can thus be raised: what is the relationship between the ability level of the student and that of the student body he enters?

IQ Constancy - Reliability of intelligence quotients has been studied for many years. Generally it has been concluded that there is relatively little variation--not more than 5 IQ points--if the same test (of alternate forms of it) is used, if the time between the two administrations of the test is not too great, and if the testing is done after age eight (54, 33, 63). However, the variability increases markedly if the time gap between the tests is great or if at least one of the scores is obtained before the eighth birthday. In one study Honzik et al (41) found that between ages six and eighteen almost 60% of the children changed 15 or more points on their IQ scores, that a third changed 20 or more IQ points, and 9% had an IQ change of 30 or more points. In the Fels Study (77) 62% of the children changed more than 15 IQ points between the ages of three and ten years.

Since intelligence quotients were available for each of the students in this study from approximately age five to age twelve, it was possible to determine the difference between the highest and lowest obtained IQ scores for each child. The results are shown in Table 4.

Some indication of the fluctuation of the scores of these individually given intelligence tests can be seen from Table 4. Sixty-four percent of the children had IQ changes of 16 points or more--equal to at least one standard deviation on the Stanford-Binet--and 36% had changes of over 21 points. In no case was the change less than 7 points. These figures are comparable to those found by Honzik despite the fact that

TABLE 4

DIFFERENCES BETWEEN HIGHEST AND LOWEST IQ SCORES OF CHILDREN BETWEEN THE AGES OF 5 AND 12

IQ Score Differences	Univ. of Mich.		Other Colleges		Total
	Males	Females	Males	Females	
7 - 9 IQ points	2	1	2	5	10
10 - 12	5	2	4	4	15
13 - 15	6	3	1	0	10
16 - 18	4	3	2	5	14
19 - 21	6	3	1	3	13
22 - 24	5	4	2	1	12
25 - 27	2	5	1	0	8
28 - 30	0	1	0	0	1
31 - 33	0	3	2	0	5
34 - 36	1	1	0	1	3
37 +	2	2	1	1	6
Totals	33	28	16	20	97

the ceiling age was six years lower.

It might be expected that the greatest differences in IQ scores would be found for those students who generally had the highest intelligence quotients. While this was true in some cases, there were students with average IQ's (90 to 109) as their lowest score who changed from 20 to 39 IQ points. Again, while the greatest variation in IQ scores tended to occur during the youngest ages, the highest and lowest IQ scores appeared at almost any age.

IQ Variability - To determine IQ variability each individual's mean IQ score was calculated and the standard

deviation (SD) of the IQ scores was then determined. The standard deviations for all individuals placed in rank order, from smallest to largest, together with the student's last IQ score and his first year CGPA are presented in Appendix D.

The male students who attended the University of Michigan were studied first. When they were divided into two equal subgroups at the median of the standard deviations, a low SD group with little variation in IQ scores over the years and a high SD group having a great deal of variation were formed. A comparison of first year CGPA's between the low SD and the high SD groups is shown in Table 5.

TABLE 5

FIRST YEAR CGPA FOR UNIVERSITY OF MICHIGAN MALE STUDENTS WITH LOW AND HIGH IQ VARIABILITY

First Year CGPA	Low SD Group	High SD Group
Below 2.0	1	7
2.0 to 2.9	7	6
3.0 or above	8	4
Totals	16	17

The mean intelligence level of the two groups in Table 5 is almost equal--within two IQ points of one another--, and it might be expected that there would be equal numbers of students in each CGPA category. Since differences between the low SD groups and high SD groups were found in the below 2.0 and 3.0 or above categories, further study seemed warranted.

Therefore, the same procedures were followed for the other groups--these groups being split into two subgroups at the median of their standard deviations also. The results with all subgroups totaled are found in Table 6.

TABLE 6

FIRST YEAR CGPA FOR STUDENTS WITH LOW AND HIGH IQ VARIABILITY

First Year CGPA	Low SD Group	High SD Group
Below 2.0[2]	7	14
2.0 to 2.9	22	23
3.0 or above	20	12
Totals	49	49

The figures in Table 6 suggest that differences between high and low SD groups may exist. The low SD group has fewer students who failed and more who received a 3.0 or above GPA than the high SD group. Whether these groups are significantly different will have to be tested when other data become available.

Correlation coefficients between the standard deviations of IQ and first year CGPA were computed. Since it might

[2]It should be noted that obtaining less than a two point CGPA the first year does not mean that these people failed academically in their subsequent work. Eight people either graduated from college later or substantially raised their grades. However, 3 people in the low SD group and 6 people in the high group continued to have low GPA's and did leave college later. In 4 cases no determination of later grades could be made.

be expected that the variability of the IQ scores would be related to level of intelligence, the r's between these variables were calculated also. Finally, multiple correlations involving both the last IQ score and the standard deviation of IQ scores were found. The results of this investigation are presented in Table 7.

TABLE 7

CORRELATION OF FIRST YEAR CGPA WITH LAST IQ AND STANDARD DEVIATION OF IQ SCORES

Factors	Univ. of Mich.		Other College
	Females	Males	Males
r_{12}	.27	-.20	.15
r_{13}	.57**	.39*	.60*
r_{23}	.41*	.35*	.67**
$r_{1.23}$	.58	.53	

1 = First year CGPA
2 = SD of IQ scores
3 = Last IQ Score

*Significant at the .05 level
**Significant at the .01 level

The relationship between IQ variability and CGPA for the first year in college is not significant; however, there is a positive relationship between IQ variability and the last IQ. The multiple correlations are not as high as those obtained previously (Table 3), although the .53 for males attending the University of Michigan is the second highest r for this group.

One further possibility was tested. Might it be possible that differences between the low SD and high SD students are obscured by grouping them together to compute the

correlation coefficients? Again the group of males who attended the University of Michigan was studied first, since, unlike their female counterparts, low r's between first year CGPA and other variables had been obtained for them.

This time the division between the two groups--low and high SD's--was arbitrarily made at a SD of 6.0, since this was approximately the median point for 3 of the 4 groups, University of Michigan female students excepted. The correlation between the first year CGPA and last IQ for the high SD group (n = 20) was .69--this being .30 points higher than the r found for the total group and a coefficient found by chance only once in a hundred times. The r for the same factors for the low SD group (n = 13) was -.21. The critical ratio between these two correlations was significant at the .01 level, indicating that these groups are probably different on this dimension.

Since nonsignificant correlations between dependent and independent variables also had been found for female students who attended other colleges (Table 2), correlation coefficients were computed for the low SD and high SD students of this group too. The resulting correlations between last IQ and first year CGPA for the high SD group (n = 11) was .48, for the low SD group (n = 10), -.10. The difference between the two groups, while not significant, is in the predicted direction.

Similar calculations were not made in the case of other college males because of the already high r's found for

them and the relatively small number in the group. University of Michigan female students also had high correlations between last IQ and first year CGPA, but, in addition, the median point of their IQ variability was higher than for any other group and was the only one which was not near the 6.0 SD mark (see Appendix D). Using 6.0 SD as the point at which the high and low groups of University of Michigan female were separated, the number in each subgroup was 20 and 9 respectively. The larger number in the high SD group was as predicted from the higher correlations found earlier for female students who attended the University of Michigan (Table 2). Actually, the correlation between last IQ and first year CGPA for the high variable group of 20 University of Michigan female students was .52 compared to .57 for the total group--a small drop and not in the direction which would be predicted.

The differences between the high and low IQ variability groups might be summarized tentatively this way:

1. The last IQ score of students in the high SD group is highly correlated with first year CGPA,
2. The last IQ score for students in the low SD group bears no significant relationship to first year CGPA, but these students are more likely than the high SD group to do satisfactory work in college.

Only further research will determine whether the differences between high and low SD groups can be attributed to chance or whether they are associated with some other factor such as anxiety, need for achievement, or late maturation.

Which IQ Score has the Highest Relationship to College Success? - Throughout this study the latest available IQ score has been used as one of the independent variables. The question can be posed: is this the best predictor of CGPA or would the highest IQ score achieved or the average of all IQ scores be better? This was investigated and the resulting correlation coefficients are presented in Table 8.

TABLE 8

CORRELATIONS BETWEEN FIRST YEAR CGPA AND VARIOUS IQ SCORES

IQ Score	University of Michigan	
	Females	Males
Last IQ	.57**	.39*
Average IQ	.53**	.32
Highest IQ	.60**	.26
Average, 2 Highest IQ's	.60**	

*Significant at the .05 level
**Significant at the .01 level

All the coefficients obtained for the female students were significant, but only one, between the last IQ and CGPA, was significant for the male students. If it were postulated that the highest IQ scores obtained reflect the greatest motivation of students, it would follow that these would correlate most highly with CGPA's, if college work also elicits maximum effort. There is slight support for this from the r's found for female students but not from the male students. However, when the relationship between highest IQ and first year CGPA

was computed separately for the high SD and the low SD groups of male University of Michigan students, the r's were .74 and -.28 respectively, a slightly greater difference between the coefficients than previously found. The differences in favor of the correlations using the highest IQ are in the predicted direction, but a test of the significance of the difference cannot be made. It can be added, though, that the highest IQ scores tended to occur at 7 years of age or later--this being found for all but four of the males and for all but seven of the females.

How Early does an Intelligence Test Score Bear a Relationship to CGPA? - As mentioned previously, the last IQ --obtained at approximately 12 years of age--has been used arbitrarily as one of the independent variables. However, the question can be raised: would the IQ found in the fifth grade, or fourth grade, or even an earlier grade correlate just as highly with later work in college?

To determine how early the relationship between an intelligence test score and CGPA exists, correlations between these factors were calculated at various ages for male and female students attending the University of Michigan. The high SD male group was treated separately. The results are presented in Table 9.

In Table 9 it appears that the IQ scores obtained for these children when they were 8 to 8½ years of age relate as substantially to CGPA as those obtained at ages 11½ or 12. Before the age of eight, however, the correlations are either

TABLE 9

CORRELATIONS BETWEEN FIRST YEAR CGPA AND IQ SCORES FROM VARIOUS AGE LEVELS

Age at which IQ was obtained	University of Michigan		
	Females	Males	
		High SD	Total
66 or 72 months	.44*		
78 or 84 months	.32	.52*	.27
96 or 102 months	.64**	.67**	.38*
108 or 114 months	.60**	.56*	.34
Last IQ	.57**	.69**	.39*

*Significant at the .05 level
**Significant at the .01 level

not significant or account for too little of the variance to be meaningful.

Differences between Students with Below 2.0 and Above 3.0 CGPA's - Two dichotomous groups of students from the total number in the study were isolated: those who received less than a two point average their first year in college and those who obtained a three point average or better. For each group information was tabulated for nine different variables. The below 2.0 group was further divided into those who subsequently succeeded and those who failed in college. The mean of each variable for each group is presented in Table 10.

The importance of the differences found among the various groups can be ascertained in several ways. First, comparisons can be made between the below 2.0 and the 3.0 or above groups--small differences between them would not be

TABLE 10

COMPARISON OF MEAN SCORES OF STUDENTS RECEIVING BELOW 2.0 AND 3.0 OR ABOVE FIRST YEAR CGPA

GPA Groups	Variables									
	n	Last EQ	Last IQ	IQ-EQ	SD of IQ	EA Slope	MA Slope	EA-MA -100	EA Y -MA Y -100	1st EA
Below 2.0 & failed	12	98	116	21.5	7.8	1.38	1.19	112	140	105
Below 2.0 & passed	12	104	121	19.5	7.8	1.35	1.26	109	134	102
Total, below 2.0	24	101	119	20.4	7.8	1.36	1.22	110	137	104
3.0 or above	31	122	138	16.9	7.5	1.71	1.49	122	141	92

sufficiently discriminatory. A second approach is to inspect the differences between the subgroups within the below 2.0 classification. Again, if the differences between them are small or if they are not in the predicted direction, there is reason to exclude that variable from further consideration. Thirdly, other variables can be excluded by examining the original data. Since certain of the scores for the above groups ranged from large negative quantities to large positive quantities, the separation of two distinct groups in these instances was impossible.

The above methods of inspection eliminate all but three of the variables in Table 10: last EQ, last IQ (used in preference to MA slope), and first EA. The first EA score

is actually the chronological age at which the first EA score appears. Since the Stanford Achievement Tests are not given to children until they have reached a status of 103 months or more on the Gates Primary Reading Tests, the first EA score is really the chronological age (CA) at which they attain this level of reading ability. Because reading age (RA) is sometimes used as a measure of EA, the CA at which the first Stanford Achievement test is given might reveal how early or late educational achievement growth started, something the Y-intercepts failed to do. Whether the RA would fulfill this function is dependent on the relationship between it and other growth factors.

Olson (63) has presented results of research by Ketcham, Langford, and others which suggests close correspondence between RA and other ability and achievement measures. Therefore, it might be concluded that little additional information is obtained when reading achievement scores are included in computations. The correlations between last IQ and the first EA for students attending the University of Michigan were -.68 for males and -.45 for females, both coefficients being significant at the .05 level. This shows a tendency, as might be expected, for those with higher IQ scores to be ahead of their CA in reading and hence given the Stanford Achievement Test at an earlier age. Interestingly, the correlations between first EA and first year CGPA for males and females, respectively, were -.11 (n.s.) and -.47 (significant at .02 level), showing the same differentiation

found earlier between the sexes.

To determine whether the means of last EQ, last IQ, and first EA were significantly different between the below 2.0 and the 3.0 or above groups, the standard error of the difference was found and the t computed. It was found that the means of the last EQ, last IQ, and first EA for the two groups were significantly different beyond the .01 level.

A critical point between the below 2.0 and 3.0 or above groups, using the means and standard deviations, was determined so that those who did poorly and those who did well during their first year in college might be differentiated. The critical figures for the three variables were:

Last EQ = 109
Last IQ = 127
First EA= 98

For the EQ figure, 75% of the group getting lower than a 2.0 average their first year in college had scores below 109 whereas 75% of the group receiving a 3.0 average or better had scores above 109. The critical scores of 127 IQ and 98 first EA divide the two groups of students similarly, with over 70% of the low group falling below the point and an equal percentage falling above it in each case.

It is more important to determine which students are likely to fail or to have academic difficulty than to predict those who will receive grades above a 3.0 average. To do this it is necessary to make a finer discrimination between those below a 2.0 average and those above. When the means and standard deviations for the last EQ, last IQ, and first EA were

calculated for the students who received between 2.0 and 2.9 first year GPA at any college, the results could be compared to the below 2.0 and 3.0 or above groups as shown in Table 11.

TABLE 11

COMPARISON OF MEAN EQ, IQ, AND FIRST EA SCORES FOR STUDENTS RECEIVING VARIOUS CGPA'S

Groups by First Year CGPA	Last EQ		Last IQ		First EA	
	Mean	SD	Mean	SD	Mean	SD
Below 2.0	101	11.7	119	13.4	104	10.4
2.0 - 2.9	107[a]	14.3	125[a]	16.2	98[b]	10.9
3.0 or above	122[c]	19.1	138[c]	17.6	92[c]	9.4

[a]Significantly different from 3.0 or above group at .01 level.
[b]Significantly different from below 2.0 and 3.0 or above groups at .05 level.
[c]Significantly different from below 2.0 group at .01 level.

While the means for all three variables are significantly different between the 2.0 - 2.9 group and the 3.0 or above group, only one mean, first EA, differs significantly between the 2.0 - 2.9 and the below 2.0 groups. Moreover, a significant difference does not even exist between the mean EQ and IQ scores when the below 2.0 group who failed is separately compared to the 2.0 - 2.9 group. Thus, while the various mean scores fall into order as might be predicted and while certain ones are significantly different from those of other groups, the overlap of the groups is too great to give more than a general approximation of how well a student might

do academically in college. Also, it appears easier to predict those who will be outstanding than those who will fail.

Unpredictable Individual Cases - A salutary note of caution can be interjected here by examining five selected cases of men who attended the University of Michigan. These men have several characteristics in common. One similarity is their EQ scores at age eleven (92, 92, 95, 96, 98) which are below the mean for the below 2.0 group. The highest of the five EQ scores would be found in only 10% of the members of the 3.0 or above group. Their last IQ scores (99, 105, 110, 112, 113) also fall into a comparably and almost identically low position. Another measure of commonality is that the CA at which their first Stanford Achievement Test was given is quite high (108, 112, 121, 123, 127); these scores being most similar to those of the below 2.0 group. All three of the factors taken collectively suggest that these five students would be fortunate to obtain even passing grades in their college work, and it would be extremely unlikely that they would receive a 3.0 CGPA or better.

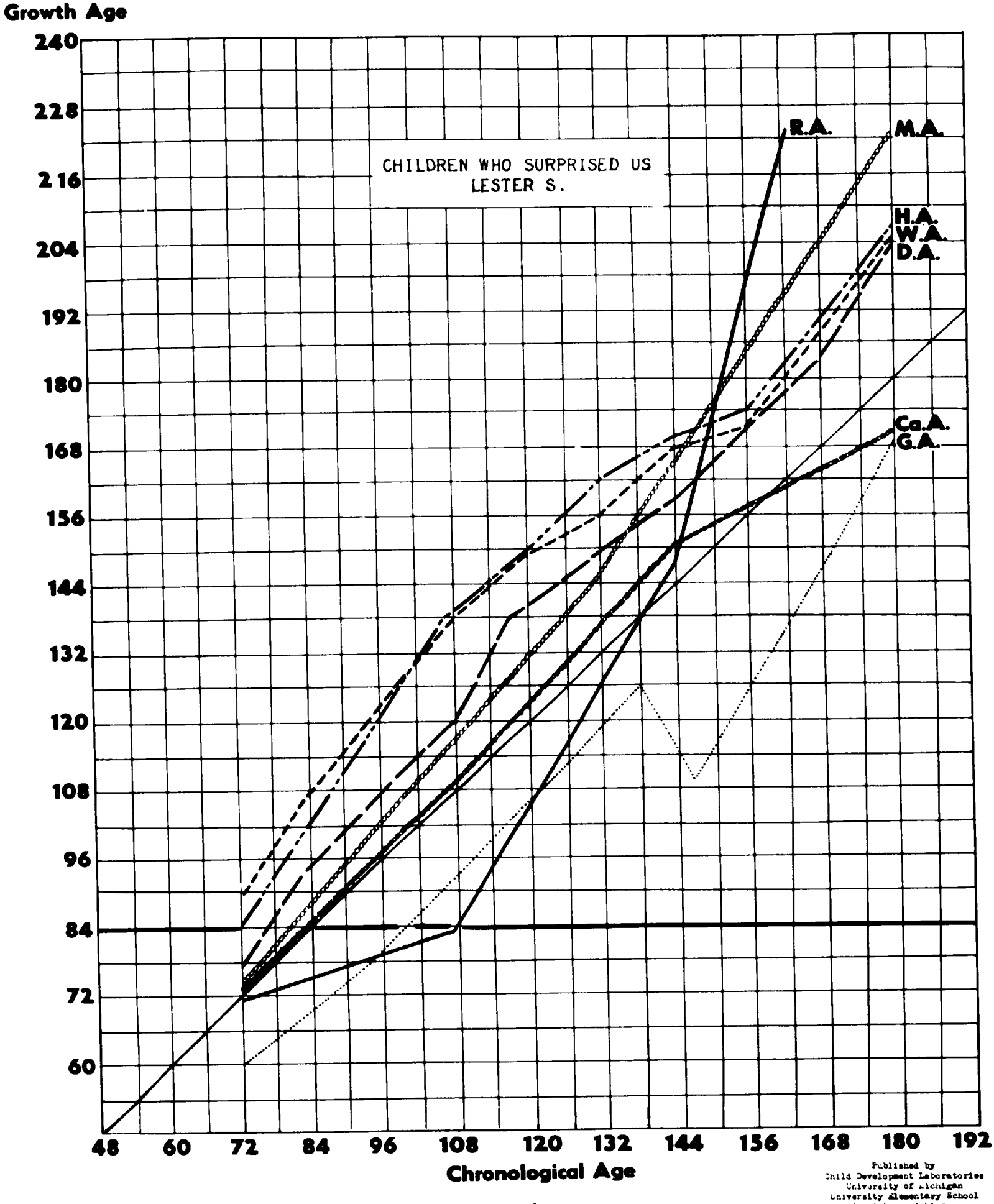
There are other points of commonality however. Each of these male students not only graduated from the University of Michigan but each had a substantial cumulative GPA at the time of graduation--2.5, 2.5, 2.9, 3.2, 3.5. Furthermore, each of these men when on to advanced work--three obtaining their master's degrees and two their M.D. degrees. Yet it is unlikely that it would have been predicted that they would excel in their academic work; more likely failure would have

been anticipated. Even hindsight does not aid in determining what transpired in these cases.

A first hypothesis might be that some pronounced changes took place in the ability or achievement level of these students after they left elementary school. Unfortunately, annual testing procedures in the post-elementary years were not yet in operation when these students were in the University School and several of them entered the University of Michigan prior to the initiation of the freshmen testing program there. Later test scores were available for three of the men however.

The growth lines of one of these three men, who has been given the name of Lester S., are shown in Figure 1. Lester's reading age increased dramatically from age 12 to 13½. His mental age also increased from an IQ of 110 on the Stanford-Binet at age 12 to an IQ of 118 (125 IQ for language and 105 IQ, non-language) on the California Test of Mental Maturity at 17 years of age. His ACE test results, taken as a freshman at the University of Michigan, were: Linguistic, 53 percentile, and Quantitative, 27 percentile. From additional data available it appears that his EA increased slowly through age twelve and that his reading skill continued to increase into his first year in college. Even though the various test scores indicate improved status as compared to the sixth grade, they do not seem adequate to explain the fact that he graduated with distinction, having a 3.2 cumulative CGPA, or that he would successfully complete medical school.

Figure 1



Published by
Child Development Laboratories
University of Michigan
University Elementary School
Ann Arbor, Michigan
1954

Another of these students, whose cumulative four-year CGPA in engineering school was 3.5, had an average IQ of 108 between six and twelve years of age and an EQ of 95 at age eleven. Test scores available for him after age twelve are as follows:

Age	Grade	Test	Score
12	7	California Test of Mental Maturity	112 IQ Total 115 IQ Verbal 111 IQ Non-verbal
13	8	Iowa Silent Reading	6-9 grade equivalent
14	9	Iowa Silent Reading	8-3 grade equivalent
College Fr.		ACE Psychological	68 %ile Linguistic 57 %ile Quantitative
College Fr.		Cooperative Reading	65 %ile Vocabulary 81 %ile Speed
College Fr.		Michigan Math	94 %ile

While the above figures cannot be fully evaluated because the norm groups are unknown and because different tests were used, there is apparent only a slight upward shift in ability through age fourteen. The freshmen placement tests taken at the University of Michigan, however, seem to indicate more substantial ability. According to information available from the Office of Admissions of the University of Michigan, the median percentile on the ACE can be equated to an IQ in the low 120's and so it would appear that his general ability scores have increased.

For the third student there was only one score available past the sixth grade. Prior to that his average IQ between ages five and twelve was 103, with a 99 IQ and a 98 EQ at

twelve years of age. At fourteen years of age his scores on the California Test of Mental Maturity were: 115 total, 123 language, and 106 non-language. Even allowing for differences in the tests, the scores on the California test appear to be higher than those obtained in elementary school. If one were to postulate a steadily increasing level of ability for this student, evidence to support it would be found in the GPA he earned in college:

2.00	First Semester
2.73	Second Semester
2.93	Second Year
3.20	Third Year
2.93	Fourth Year

Until the fourth year there was an increase which equalled more than one grade letter.

The post-sixth grade test results are not complete enough to reveal why these students with such modest test scores in elementary school should do so well in college. It is possible that these five students had special abilities which enabled them to be successful in their particular field of study in college. Whatever these special abilities might have been--mathematical, factual memory, scientific--, a single, composite IQ score might not give sufficient weight to them. There is support for this explanation in the type of programs these men entered in college: two were in medicine, two in engineering, and one in speech.

There is one final characteristic which these students share in common, and it reintroduces a problem previously left unresolved. This final similarity is: Each of these students

is in the low variability group mentioned earlier, i.e. their IQ's over a period of at least six years prior to age twelve were quite constant.

There seems to be no satisfactory explanation as to why variability of IQ scores should have any effect on later performance. While IQ variation has been noted in other longitudinal growth studies (6, 60), its relationship to academic achievement has not been mentioned. Further study might determine whether this is a chance relationship or, if not, why the relationship exists.

A possible direction for future research is suggested in a recent monograph (77) which relates findings from the Fel's study. It was found that changes in relative mental ability do occur in childhood and that these are apparently associated with general acceleratory or deceleratory factors which are unrelated to any testing artifact (77). While these general acceleratory and deceleratory factors were found at all ages, there was an important sex difference noted:

> Significantly more boys than girls were found to have accelerative patterns in their trend lines, particularly during the school years (77 - p. 54).

The authors explain these shifts with the terms "learning to learn" and suggest that many types of antecedent conditions at the different age levels are responsible for it (77 - p. 55).

Further suggestions for research can be entertained here. An investigation could be made of "late starters," students who suddenly blossom out in their later years in school, to determine what is actually associated with this acceleratory

trend. Perhaps the phrase "learning to learn" could be operationalized and studied in the case of late starters.

It might also be possible to specify more exactly what the terms "underachievers" and "achievers" mean. Are "achievers" also the ones who have constant IQ scores? What factors are associated with IQ variation? Is IQ variation associated with changes in the child, the test, or the interpersonal relationship between the child and the psychometrist? If the change occurs within the child, at least partially, can it be identified through some other means--e.g. measures of anxiety, need for achievement, or similar types of measures?

Discussion of the implications of IQ variability will be continued in Chapter VI. The five cases cited serve as a caution against overconfidence in making early predictions of success and failure in college work.

Relationship of Student to College - The average level of ability of students at different colleges varies greatly. Such differences in student bodies have been found in various studies. Henderson (37) mentions several instances where colleges which were adjacent geographically had student bodies with markedly different ability levels. In one case he reports the freshmen classes of two colleges had median percentile scores on the American Council on Education Scholastic Aptitude Test of 16 and 60 respectively (37).

While it is apparent that colleges differ in respect to the ability of their student body, the standing of any particular institution is inviolable. It is understandable why

the ranking of an institution would be closely guarded, but without such information high school counselors are not as able to advise their students effectively as to choice of college. Moreover, this lack of information makes it difficult for those doing cross-college studies to compare results obtained from one student body to those of another.

In the present study it was realized that adjusting CGPA to a common base left ability level differences between student bodies unchanged and that this could measurably influence the CGPA achieved by the student. This problem has been recognized by others and there are some current attempts to remedy the situation--a most promising one in which grades from both secondary schools and colleges are adjusted to a common scale has been developed by Bloom and Peters (78). It seemed unlikely that assistance in equating CGPA's of different colleges would be available for this study from an outside source. Not only is such information closely guarded, but no single research project provides data for all the institutions attended by the students in this study. Without a common base --an instrument like the CEEB Scholastic Aptitude Tests or the ACE Tests--the situation would be little modified.

One course of action was available however. An index of student ability for a particular institution might be estimated from the achievements of their graduates as evaluated by the Knapp studies (49, 50). In the Knapp studies certain post-college scholarly undertakings or recognition of such accomplishments were specified and the number of graduates

from each institution found in this category was determined. This figure was plotted against a base of the total number of graduates of each college for a specified period of time so that an index number indicating the percentage of graduates who fit the criteria was obtained. Using the index numbers from both studies (49, 50), a mean index number was found for a number of institutions, including most of those attended by University School students. In a few cases where only one index number was available it alone was used. In two cases where no index number was found in either Knapp study, the colleges were not included.

The colleges and their index numbers, placed in rank order, are shown in Table 12. The list of colleges was divided into three groups: high (above 30), medium (from 13 through 29), and low (12 or below). The division was arbitrary but based on the mean and the standard deviation of the index numbers.

Just as each college can be classified as low, medium, or high in terms of general student ability level, so can each student be classified in the same way. The last IQ was used to divide the students into three groups: low (114 IQ or less), medium (115 to 129 IQ), and high (130 IQ or above). By matching student and institution on these scales it was possible to find out the type of institution selected by students of different ability levels. The results are presented in Table 13.

While the comparisons made in Table 13 are gross and the numbers involved are small, the relationships are as might

TABLE 12

MEAN INDEX NUMBERS FOR SELECTED COLLEGES[a]

College	Mean Index Number	
Reed	92	
California Institute of Technology	54	
Oberlin	48	
Swarthmore	46	High
Antioch	38	
Carleton	34	
Harvard University	23	
Kenyon	22	
Cornell University	21	
Radcliffe	20	
Knox	20	
St. John's College (Md.)	20	Medium
University of Wisconsin	19	
Yale	19	
Miami University (Ohio)	16	
Brown	16	
Dartmouth	13	
University of Michigan	12	
Denison	12	
University of Colorado	12	
Smith	12	
Purdue	10	Low
Albion	10	
Duke	9	
Eastern Michigan	8	
Michigan State University	8	
Hillsdale	7	
Western Michigan	5	

[a]Index numbers obtained from the Knapp studies (49, 50).

TABLE 13

ABILITY LEVEL OF STUDENT COMPARED TO ABILITY LEVEL OF THE COLLEGE STUDENT BODY HE ENTERED

Ability Level		Number of Students		
Student	Student Body	Male	Female	Total
Low	Low	4	7	11
Medium	Low	2	4	6
Medium	Medium	1	4	5
High	Low	1	1	2
High	Medium	2	1	3
High	High	4	3	7
	Totals	14	20	34

be predicted. Of the total of 34 students, 23 of them went to institutions with the same ability designation. All of the others went to institutions having a student body lower in the ability classification. Not one student went to an institution with a higher ability status!

If it does nothing else, the comparison suggests that students do enter college where the student bodies have a level of ability commensurate with their own ability or lower. Many factors probably determine this self-selection or mutual selection, but the fact that it does occur provides support for using the Knapp index numbers to determine the ability standing of a college student body.

There would be stronger support for utilizing the index numbers if the relationship of student to student body revealed how well the student would do academically. It was

postulated that a person attending an institution with a student body comparable to his own ability level would earn average grades, i.e. between 2.0 and 2.9 GPA. It then would follow that any one attending an institution where his ability was higher than that of the average group would be likely to attain higher grades--a 3.0 GPA or better. Conversely, had any student gone to an institution with a higher ability classification, he would have most probably received below a 2.0 average.

The resulting first year CGPA for students when their ability classification is compared to that of the college they attended is indicated in Table 14.

TABLE 14

FIRST YEAR CGPA OF STUDENTS WHEN THEIR ABILITY DESIGNATION IS COMPARED TO THAT OF THE STUDENT BODY THEY ENTERED

Ability Designation		Students Attending Other Colleges	
Pupil	College	Males	Females
Low	Low	2.2[a], 2.2[a], 1.6 2.8[a]	2.3[a], 1.3, 2.5[a], 2.6[a] 2.8[a], 2.1[a], 2.2[a]
Medium	Medium	2.2[a]	2.9[a], 2.7[a], 2.0[a], 1.8
High	High	3.2, 3.2, 3.5 3.5	2.4[a], 1.8, 2.0[a]
Medium	Low	2.2, 1.2	1.9, 3.7[a], 3.0[a], 3.7[a]
High	Low	2.4	3.4[a]
High	Medium	4.0[a], 3.4[a], 1.8	2.4

[a]CGPA's that are as predicted

In Table 14, 6 of the 15 grades for males and 15 out of 20 of those for female students are as predicted. If a minor change is made in the criteria--the inclusion of those in the high-high group who received better grades than predicted--, the total for men is increased to 10 out of 15. This change is reasonable because the range of IQ's above 130 is great enough to cause variations in grades. Of course, the same modification can be made for those in the low-low group--IQ variations downward being associated with lower CGPA's than expected. There is some support for this expectation: the two people in the low-low group who received first year grades below a 2.0 average had IQ's of 95 and 106. However, there were five others with IQ's ranging from 80 to 107 who did succeed.

There is a further method of determining whether the Knapp index numbers give an indication of the ability level of a student body. This is accomplished by examining changes in CGPA for students who transferred from one institution to another. Presumably, a person transferring between institutions of comparable level should earn approximately the same grades, while those attending institutions with student bodies of higher or lower ability levels should correspondingly receive lower and higher CGPA's. Fourteen people in this study transferred to or from the University of Michigan and CGPA's were available for at least a year or more at both institutions they attended. Upon comparison of the total CGPA's of both institutions, the differences between them were obtained and

are presented in Table 15.

TABLE 15

DIFFERENCES BETWEEN CGPA AT THE UNIVERSITY OF MICHIGAN AND CGPA AT OTHER COLLEGES FOR STUDENTS WHO TRANSFERRED

Classification Level of Both Institutions		CGPA Increase or Decrease at Latter Institution		
		Grade Up	No Change	Grade Down
Low	to Medium[a]			-.3[b], -.4[b], -.6[b] -.8[b], -.9[b], -1.6[b]
Medium[a]	to Low	.7[b], 1.2[b]		
Medium	to Medium[a]	.3, .4	.1[b], -.1[b]	
High	to Medium[a]	.3[b], .5[b]		

[a]This refers to the University of Michigan.
[b]Predicted direction of CGPA change.

The University of Michigan occupied a position within the low classification in Table 12, but it was necessary to discriminate between it and institutions having smaller index numbers. Therefore, the medium group was extended one index number downward, thus encompassing the University of Michigan, the University of Colorado, Denison University, and Smith College. CGPA's not changing more than .2 in either direction were considered to be the same; those varying more than that were considered different. On this basis, 12 of the 14 differences in CGPA in Table 15 are as predicted. The only two changes not predicted--the changes of .3 and .4 in the Medium to Medium group--are both for students who transferred from Denison University to the University of Michigan. This may

indicate the necessity of elevating the classification of Denison to a higher position than that of the University of Michigan.

Evidence for using the Knapp index numbers as an aid for counselors in secondary schools is insufficient. The small number of cases involved in this study and the unrefined techniques used argue against surety in using the index numbers for predictive purposes. Yet, the results are impressive enough to warrant further study and the calculations are simple enough to be widely used if substantiated by subsequent research.

In this chapter the results of the investigation were related to the original hypotheses and other findings were presented. Various conclusions remain to be discussed. These, together with suggestions for future studies, will be developed in the next chapter.

CHAPTER VI

SUMMARY, CONCLUSIONS, AND IMPLICATIONS

Long-term growth records of nearly one hundred students have been studied to determine their relationship with CGPA. This chapter contains a summary of the findings, conclusions which have been drawn, and a discussion of the implications of the study.

The exploratory orientation of this study should again be emphasized. Because of the longitudinal nature of the study, limitations were placed on the numbers and types of people involved and on the nature of the information available about them. No assessment can be made as to the effect of these limitations on the results obtained. It is possible that certain variables--socio-economic, ability, primary and secondary school experiences, and college environment (for those attending the University of Michigan)--might have been held constant. However, the homogeneity of the group might also have had the effect of lowering the relationships found between growth variables and college performance. While application of the results to other groups cannot be made with any assurance, certain of the findings are suggestive enough to indicate the desirability of follow-up studies.

Broader Implications of the Findings

1. Value of Longitudinal Data - Longitudinal growth records have proved valuable in learning more precisely how children actually grow. No other approach has the descriptive power of the longitudinal method. In this study, however, longitudinal techniques were analyzed as to their predictive power, and it is on this basis they are being evaluated.

The slopes of both the EA and the MA lines for the total groups of males and females correlated positively with first year college grade point average. However, the correlation coefficients between the slope of the line and CGPA were generally lower than those between single test scores obtained in the sixth grade and CGPA. Since no significant relationship was found between the Y-intercepts and CGPA, and since the r's between slope of line and CGPA were low, the use of either the slope of the line or Y-intercepts to predict CGPA is questionable.

Why the correlations of EA and MA slopes with CGPA were no higher than they were warrants discussion. Several possibilities seem apparent. One of the primary influences may be related to the use of growth data obtained before age seven, a period of admittedly extreme fluctuation in IQ scores. Future research might utilize longitudinal growth records for only the final years of elementary school. With the additional testing being undertaken in the junior and senior high school grades of the University School, growth records will soon be available through the twelfth grade. Use of longitudinal

measures for the study of growth during the adolescent period may provide pertinent information on changes in growth patterns during these later years of schooling.

Longitudinal records, particularly if represented on graphs, may reveal other aspects of growth. For example, the late maturer could be seen emerging from his chrysalis stage. There may be advanced warnings of this breakthrough, such as the sudden upsurge in reading ability followed by advancements in other areas. The inflection points between acceleratory and deceleratory rates of growth, as well as the rates themselves, found in the Fels study (77) could be studied more fully.

Future studies using longitudinal data might limit the scores used to compute slope of the line to those found at 84 months of age or later. It should also be possible at that time to use IQ test scores solely from the Stanford-Binet Test, thus controlling for differences between intelligence tests. Special attention should be focused on types of growth patterns and their bearing on future achievement.

2. Status Measures - From this study correlation coefficients between status scores from single tests and CGPA appear to be as high as, or higher than, those involving longitudinal measures and college achievement. In fact, IQ measures obtained as early as the third grade showed a substantial relationship to college performance.

The ability scores used throughout this study were all obtained from intelligence tests which were individually

administered. It is not known whether group tests would show the same relationship, but it is possible that individual testing procedures introduce elements into the situation not present in group testing sessions, including those of the Stanford Achievement Test. Further discussion of the effect of the testing environment on test scores will be found in the section on IQ variability.

The emphasis thus far has been on intelligence testing. Do achievement test scores add greatly to the information provided by measures of general ability? The evidence is not clear. For instance, in the fifth grade the correlation coefficients between EQ and IQ for male and female students who went to the University of Michigan were .78 and .73 respectively. If measures of ability and achievement are highly related, the least expensive test to administer may be used solely if two further conditions are met: (1) the relationship of both tests to future performance is equally high, and (2) no additional information is provided by the discarded tests. The second condition will be discussed in the next section, but information bearing on the first condition will be presented here. Correlation coefficients calculated between the first year CGPA and EQ at various ages for female students who attended the University of Michigan were:

EQ at CA of 100 mos.	.43
EQ at CA of 106 mos.	.50
EQ at CA of 112 mos.	.35

The two correlations at the ages of 100 and 106 months are significant. The r between IQ at 96 or 102 months of age

and CGPA is .64. Further studies of the relationship of EQ and IQ to later academic performance may reveal whether IQ scores show an earlier significant relationship with college grade point average than do EQ scores and whether the relationship of EQ to CGPA continues to increase.

Unexplained differences exist between male students who went to the University of Michigan and those who went elsewhere. For male students attending other colleges the correlation of first year CGPA with EQ at age eleven was .71 and with last IQ was .60. However, the correlations for the same variables for University of Michigan male students were .25 and .39 respectively. The comparable coefficients for the high SD male University of Michigan students were .52 for EQ and .69 for IQ. The differences between the r's of ability and achievement scores with CGPA suggest that both types of tests be included in research programs until more is known about these measures.

3. The Difference between Ability and Achievement Scores - The amount of disparity between scores on the Stanford-Binet and on the Stanford Achievement was used as a measure of underachievement and achievement. The difference between intelligence scores and achievement scores was found and was correlated with first year CGPA and last IQ--the resulting coefficients being:

	Correlation of IQ - EQ with: 1st Year CGPA	Last IQ
Female Students (Univ. of Mich.)	-.15	.41
Female Students (Other College)	.11	.61
Male Students (Univ. of Mich.)	.04	.37
Male Students (Other College)	.29	-.02

No significant relationship was found between IQ - EQ and first year CGPA, while all the r's between IQ - EQ and last IQ were significant at the .05 level except the r of -.02 for male students attending other colleges which was not significant. Thus, there is little evidence for using the differences between IQ and EQ scores as predictors of college success. The above findings do not necessarily rule out other approaches: it may be that the IQ - EQ relationship is not amenable to linear correlational procedures; perhaps it is curvilinear or it may only be significant in conjunction with other factors.

In Table 10 differences were found between the means of the IQ - EQ scores for the various groups. When these scores were further analyzed, it was found that 40% of those who failed in college had IQ - EQ differences of over thirty points, whereas the group who had below 2.0 GPA their freshman year who later succeeded in college and the group who had 3.0 GPA or above their first year in college each had only 10% of their members with this large a difference. Furthermore, the percentage of students having 20 to 29 points difference between IQ and EQ was twenty for the group who failed and fifty for the other two groups. A larger sample would be needed to determine whether these differences are significant.

Another method of evaluating the relationship between achievement scores and college success, using longitudinal data, involves a measure of reading skill. It is likely that reading achievement is an important element in test taking and in scholastic work, and lack of reading skill may account for a part of the difference between scores on the Stanford Achievement Test and the Stanford-Binet Test. In addition, changes in reading ability might herald increased scores on other measures of achievement. The differences between early reading tasks which appear to be largely perceptual and later reading which is more conceptual and hence more highly correlated with IQ tests is discussed by Smith (76). It is possible that reading ability takes on a critical role in affecting early achievement test results but has progressively less effect on later achievement tests and little effect on individually given intelligence tests. The possibility of using reading level at a specific age as an indicator of earliness or lateness of beginning growth should not be overlooked since there was evidence of a relationship between reading achievement and CGPA.

Patterns of underachievement and achievement might be explored more fully through the use of longitudinal records. In one recent study (74) in which grades throughout the school years were compared for students with IQ's over 110, it was discovered that male underachievers could be distinguished as early as the first grade whereas such a distinction could not be made for the female underachievers until the ninth grade.

The variables that influence these achievement patterns are still unknown, and more sophisticated research will be needed to determine what factors are predisposing or reinforcing to the elicitation of different patterns of achievement.

Future research is likely to be directed toward a determination of the effect of personality variables on achievement. Recently Lum (52) found overachievers had stronger motivation for studying, were more self-confident, and had a greater capacity for working under pressure, while underachievers tended to procrastinate and rely more on external forces. These differences might be related to the anxiety level of the student--the amount having either a debilitating or a motivating effect. There is some evidence that underachievers have other characteristics in common--the constellation including poorer performance in high school science courses, a preference for social science courses, less certainty of vocational choice, and a tendency toward extroversion (34).

It is also possible that the need for achievement is associated with hope of success for some students while for others it is a fear of failure which is motivating (3). This possibility was suggested in a report which is part of an on-going study of motives initiated by McClelland and carried on by a great many people, including Atkinson who has compiled most of the extant findings into a single volume (3). The new scoring procedures for the Thematic Apperception Test (TAT) devised by McClelland, Atkinson, et al may prove useful

in discovering how achievement motivation develops. In fact, in the Fels study (77) it has already been found that high need for achievement is related to an accelerated growth rate of mental ability. This need, in turn, seems to be associated in the case of boys with a mother who uses democratic principles of disciplining the child and encourages him to engage in independent achievement activities (77). Substantiation for these findings comes from a study by Kent and Davis (45) who found that boys who had had a demanding home environment had higher Stanford-Binet IQ's than those who came from more permissive homes; however, those from the former group also were less adaptive and became disorganized more easily when confronted with unfamiliar task situations (45).

Studies in which need for achievement has been related to college grades have had inconsistent results. In one recent study (92) in which 60 male freshmen students were given three types of tests it was discovered that achievement motivation, determined from the TAT, correlated .34 with CGPA. The TAT pictures in combination with a local academic aptitude test correlated .63 with CGPA. However, need for achievement and test anxiety were not found to correlate appreciably with GPA for a group of superior students at the University of Michigan (10).

Evidence presented in these last two sections suggests that differences do exist between tests of ability and tests of achievement. The nature of these differences and the relationship of both types of tests to different aspects of

development, the sex of the child, and other factors is not clear. The inclusion of both achievement and intelligence tests in a research program is supported however.

4. Sex Differences - This study provides evidence that males and females should be treated separately when predictions of college performance are made. Differences between the sexes were noted when the following factors were correlated with CGPA: EA slope, MA slope, EQ at age 11, and last IQ. There also seemed to be sex differences in the amount of variability of IQ scores and the effect this had on covariance between SD of IQ and CGPA. Even in the pairing of student with college there were differences in the relationships found for male and female students.

Differences in scholastic achievement and test performance between the sexes have been reported elsewhere (3, 63) but seldom explained. These differences are probably related to many factors including biological inheritance and varying environmental experiences. In this study the differences found may result from a temporal factor, i.e. since girls generally mature earlier than boys, their ability and achievement patterns may also be established earlier. This can be tested when records of growth during adolescence become available. Emotional differences such as the greater docility of girls should also be examined as to their effect on test taking and academic achievement. The important conclusion suggested by this study, however, is that when predictions of college success are made they should be made

separately for males and females.

5. IQ Variability - The discovery of the relationship of IQ variability and CGPA in this study conforms almost classically to the "law of serendipity" suggested by Skinner (75), but the implications of the relationship are as evasive as the Chesire Cat. The high correlation found between last IQ and CGPA for male students with fluctuating IQ scores and the absence of a relationship between the same variables for those male students attending the University of Michigan who had consistent IQ scores needs further study.

If similar differences between low SD groups and high SD groups are found in larger samples, then the major task confronting researchers will be to isolate the cause of the variation in IQ scores. Variability in IQ may be associated with changes in the child, the test, or the testing situation. Longitudinal records should provide an indication as to whether the fluctuations in IQ scores are random and therefore not a function of internal growth forces. The similarity of performance on IQ tests when the same child and psychometrist are involved as compared to situations where the test administrator is different may give further evidence as to the source of variation. The variation in IQ results may also be associated with the unreliability of early IQ scores. This could be controlled by limiting the IQ test scores used to those obtained after age seven.

Another direction for future research involves learning more about how various personality factors affect IQ test

scores. To do this it would be necessary to gather other information about each child in addition to mental and physical growth measures currently collected. Some type of personality index obtained through the years could prove important. Even if this measured only a few factors such as anxiety level and impulsivity these might provide a broader perspective of the variables involved in measuring intelligence. If at the same time similar personality traits were also found for the psychometrists, the effect of the interpersonal interaction in the testing relationship might become clearer.

6. Relationship of Student to College - The success of a student at college is a function not only of his characteristics but also of the characteristics of the college community which he enters. It would seem important, therefore, to know as much about the college as is known about the student and it would follow that factors which are vital to a successful pairing of college and student could then be determined.

To date, most research in the above area has related the ability and achievement records of students to those of the student bodies of their colleges. Usually this is done by the admissions officers of a particular college because the average scores for entering freshmen are not ordinarily available to those outside the institution. It is even possible that the lack of availability of these figures has led to the proliferation of multiple applications for admissions since both high school students and their counselors

lack substantive information in this area.

In the future it is possible that college administrators will re-evaluate their objectives and will set admission goals for segments of students according to their ability level. This would seem preferable to the present attempt to enroll freshmen classes with successively higher mean ability scores each year. Knowledge of the composition of college freshmen classes could then be made available to high school counselors, and they would be able to tell their students more precisely how they compare to the student bodies of the colleges they are considering. A method of matching student and college, using the index numbers from the Knapp studies (49, 50), was presented in Chapter V. Although it provides only an approximate estimate of college achievement, it provides enough information to make further study advisable. More sophisticated methods are currently being developed (78).

Does the pairing of student and college on the dimensions of ability and achievement exhaust the matching that can be done? Not at all. Pace (66) and Thistlethwaite (83) have attempted to determine the psychological characteristics of the college environment and to compare these with certain personality traits of the student. Pace has developed a "College Characteristics Index" which may bring to light stresses and the lack of congruence between stated aims of an institution and its actual operational functioning that could have a disintegrative effect on the college community. In addition, Pace (66) suggests the correspondence between environ-

mental press and individual needs may be very important to student academic achievement. Thistlethwaite (83) has viewed the college environment as an important determiner of student motivation to seek advanced intellectual training--such as Knapp surveyed--and has tried to isolate those aspects of student culture and faculty press which provide this orientation.

McConnell (53) reports other attempts to broaden the base for predicting success in college. One approach involved giving the Strong Vocational Interest Blank to 12,000 Minnesota high school graduates. This could provide information as to the composition of students at different colleges and in various courses of study. Several years later the National Merit scholars were also given the Strong VIB and a special questionnaire to determine more precisely their interests and motives (53).

The total character of a campus is a fundamental part of the process of determining which college is for which student. While there is enough variation in types of American colleges for Cain et al (58) to conclude that almost any high school graduate can get a college degree if he attends an institution adapted to his ability level, it would seem advisable for college administrators to more explicitely tailor-make their programs for students with certain abilities (29). In the future more may be learned about the composition of student bodies not only in terms of ability but also in regard to needs, values, flexibility, anxiety level, and other

characteristics of students. At that time it may be possible, as Henderson has suggested, for "...public institutions (to) diversify as to types of programs, characters of student bodies, and levels of achievement" (55 - p. 108).

7. Personality Factors - In most of the preceding summary sections the relation of personality factors to academic achievement in college has been mentioned. The fact that it has re-occurred suggests it may be important, but the effects of personality characteristics on college performance have been little studied because of the difficulty of assessing these traits. There are indications that progress is being made in this area.

Motivation is undoubtedly one of the major components of success in academic work. Donahue et al (20) indicate that measures of interest in conjunction with other tests aid in the prediction of CGPA. Cain and others (58) cite the use of an Effort Index which better predicts college grades of students with high ability.

What is needed is a more thorough understanding of the student. Roth (71) has made a strong appeal for orienting future studies of college success toward causation--he suggests toward the student's adaptation to the academic situation--and away from cross-sectional approaches which he feels obscures individual differences, particularly among the unsuccessful. A determination of the forces which block achievement would be a major breakthrough. Researchers have isolated some of these factors, at least among superior students--low

achievers being socially skillful, flexible, impulsive, etc. (39). More interest is now being centered, thanks to Russian scientific advances, on the superior student. However, there are some indications that the truly creative person might not be identified as such by his teachers because of his unpleasant personality characteristics (40). The creative student tends to be: emotionally mature, dominant, adventurous, emotionally sensitive, introverted, radical, tense, unsociable, depressive, impulsive, and less subject to group standards--qualities which would not endear him to many of his teachers (40).

While little is known about gross personality patterns of students or major characteristics of campus populations, even less is known about the more specific reactions of a student in the classroom situation. More attention needs to be focused on the classroom since this is the site of formal learning, the place where grades are acquired, and where all competencies for and blocks to achievement are magnified. Some inroads have been made. McKeachie (55) has found some of the effects of anxiety associated with student performance and has determined teaching methods which reduce tension. He concludes, however, that "...we actually know very little about why a student comes to class or how he perceives the classroom situation" (55 - p. 160).

One further area for research can be mentioned. This involves the impact of the college on the individual. In the current study the criterion of college success has been CGPA,

an admittedly limited and shallow indicator of achievement compared to the potential richness of a college program. How vital an effect college has on individuals has been a moot point since the publication of Changing Values in College by Jacob, for he found that the college had little effect on the value systems of students (44). Perhaps changes in students' values are too much to expect, but it would seem important to know more about which kinds of students are affected by which kinds of experiences so that the educational impact of a college program could be intensified.

Conclusions

This study has related the elementary school records of a select group of students with their academic accomplishments in college. Certain tentative conclusions seem justified by the data.

a. When the slope of the growth line was determined and correlated with first year CGPA, it was found that longitudinal growth data do not relate more highly to college performance than do scores from single tests. The relationship between longitudinal records and college achievement may be higher if techniques different than those employed in this study are used. Longitudinal growth data may also make it possible to determine whether individuals continue to grow progressively farther apart in their abilities and interests throughout the high school and college years.

b. Measures of ability, as revealed by the individually-given Stanford-Binet Tests of Intelligence, correlate

significantly with CGPA at approximately the third grade level. Significant correlations between scores on the Stanford Achievement Test and CGPA seem to occur at a slightly later age but may even be higher than those for IQ in later grades. There appear to be sex differences and differences which may be related to unmeasured personality traits--the contrasts between the low and high IQ variability groups of University of Michigan male students perhaps reflecting this latter point. It could not be determined whether the earlier development of females was responsible for the differences found between them and male students in this study. More research should be undertaken on the relationship of ability and achievement measures.

c. More information is needed concerning the characteristics of individuals and of colleges so that the experiences students have in college will be maximally effective. The research needed in this area, exploration of dimensions of personality and social interaction, will be both novel and difficult.

American higher education stands unique in the world. Some of its historical antecedents have been presented in an attempt to explain its multi-faceted role in our society. The variety of types of institutions and programs is great, but this heterogeneity, coupled with the new national ethos of a desire for post-high school education for more and more students, creates problems in matching students and institutions not found in other countries. While other nations are

for the most part preoccupied with selecting a small minority of students by well-established methods, the American interest is in placing a large segment of high school graduates in institutions where they can successfully further their development. To competently aid in the process of matching student and college, counselors could well use the vaunted wisdom of Solomon, but the results of further research will probably be more helpful and more readily acquired.

Until further research enhances our predictive techniques it would be unwise for any counselor to categorically make predictions of success or failure for individual students. It is sobering to note that a girl who had an average IQ of only 74 between nine and twelve years of age graduated from college and is now filling an important position in her community. The fact that the best of the predictive devices account for only a third to a half of the variance when correlated with college performance strongly argues against using them as the sole basis for predicting college performance. It also raises strong doubts about the efficacy of the "eleven-plus" examinations used in England. Some persons doubt whether we will ever be able to make conclusive predictions of college achievement since individual potentiality is so great and its expression is so varied (1). Our concern at present, however, can be directed towards the most effective pairing of student and college that is possible with present knowledge.

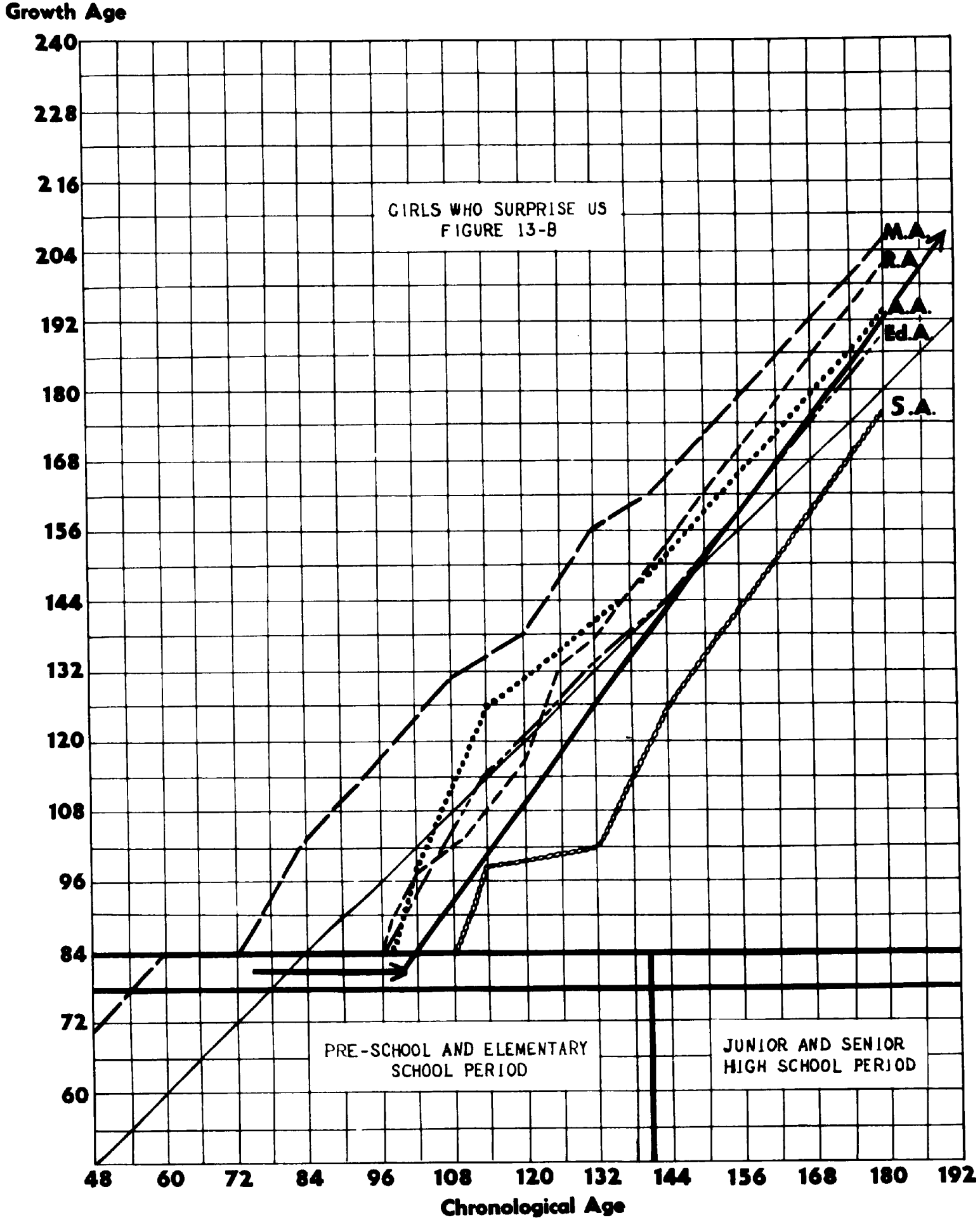
The goal throughout this study might be summed up by a question posed by Henderson: "How can we best determine

the talents and needs of individuals, so that each person in his growth will be continuously progressing?" (37 - p. 316). Perhaps this study has not only provided new information for predicting college achievement but has also posed new questions prompting the search for more of the answers so vitally needed.

APPENDIX A

YEAR OF BIRTH OF MALE AND FEMALE STUDENTS LISTED BY INSTITUTION OF FIRST ATTENDANCE

Year of Birth	Females		Males	
	U. of M.	Other College	U. of M.	Other College
1925	0	0	2	0
1926	1	0	0	0
1927	2	1	1	0
1928	3	2	3	0
1929	2	0	2	1
1930	1	0	2	2
1931	0	0	8	0
1932	0	2	1	0
1933	6	1	3	1
1934	0	3	4	0
1935	1	1	0	3
1936	3	1	4	0
1937	1	0	0	2
1938	5	3	1	3
1939	0	3	2	2
1940	3	3	0	0
1941	0	0	0	1
Totals	28	20	33	16


Growth Age
240
228
216
204
192
180
168
156
144
132
120
108
96
84
72
60
GIRLS WHO SURPRISE US
FIGURE 13-B
M.A.
R.A.
A.A.
Ed.A.
S.A.
PRE-SCHOOL AND ELEMENTARY SCHOOL PERIOD
JUNIOR AND SENIOR HIGH SCHOOL PERIOD
48
60
72
84
96
108
120
132
144
156
168
180
192
Chronological Age

APPENDIX C

LIST OF COLLEGES OF FIRST ATTENDANCE

Name of Institution	Number of Students Attending	
	Male	Female
Albion College	1	
Antioch College	1	
Brown University	1	
Carleton College		2
Central Michigan University	1	
Dartmouth College	1	
Denison University		3
University of Detroit	1	
Duke University	1	
Eastern Michigan University	1	1
Hillsdale College		3
Kenyon College	1	
Miami University (Ohio)		2
Michigan State University	3	4
Oberlin College	3	
Radcliffe College		2
St. John's College (Md.)	1	
Stephens College		1
Smith College	1	
Western College for Women		1
Totals	16	20

APPENDIX D

STANDARD DEVIATION OF IQ SCORES, LAST IQ, AND FIRST YEAR CGPA FOR MALE STUDENTS

Men, U. of M.			Men, Other College		
SD of IQ	Last IQ	1st Year CGPA	SD of IQ	Last IQ	1st Year CGPA
3.1	108	3.6	2.0	115	2.2
3.1	140	2.8	2.8	114	2.2
3.4	130	3.0	3.1	130	3.2
3.7	109	3.3	3.5	148	3.4
4.0	129	2.1	3.5	120	3.0
4.2	103	2.4	4.8	102	2.8
4.4	130	3.1	5.2	138	4.0
5.5	120	2.0	5.5	113	2.2
5.6	146	2.6	5.6	129	.03
5.7	139	3.6	6.6	126	1.2
5.8	112	3.0	6.9	103	1.6
5.8	143	1.9	7.1	123	2.2
6.0	111	2.8	9.1	137	3.5
6.0	127	3.8	10.4	130	2.4
6.5	133	2.9	11.7	132	1.8
6.6	133	3.1	12.5	158	3.2
6.7	126	2.2	18.6	171	3.5
6.9	108	1.6			
7.0	119	1.8			
7.2	125	1.7			
7.3	113	2.0			
7.5	148	3.3			
7.6	148	3.2			
7.9	121	2.0			
8.0	99	1.4			
8.1	109	1.9			
8.1	145	2.5			
8.4	139	2.7			
9.6	131	3.1			
9.9	116	2.8			
14.6	123	1.8			
15.0	134	1.8			
16.3	178	3.5			

APPENDIX D (Continued)

STANDARD DEVIATION OF IQ SCORES, LAST IQ, AND FIRST YEAR CGPA FOR FEMALE STUDENTS

Women, U. of M.			Women, Other College		
SD of IQ	Last IQ	1st Year CGPA	SD of IQ	Last IQ	1st Year CGPA
3.6	118	2.0	2.7	126	3.0
4.1	125	2.0	3.1	107	2.3
4.4	129	3.5	3.2	125	3.3
4.8	135	2.5	3.3	111	2.5
5.5	111	1.1	3.4	114	2.9
5.6	140	2.4	3.5	130	2.4
5.8	108	1.5	3.9	121	3.7
5.9	128	1.9	4.1	120	2.3
6.4	134	2.3	5.1	133	1.8
6.6	138	3.2	5.6	123	2.0
6.7	130	3.2	6.0	124	2.7
6.9	100	1.9	6.1	119	1.8
6.9	141	3.4	6.1	107	2.1
7.2	132	3.8	6.9	114	2.6
7.3	131	3.0	7.3	108	2.8
7.5	101	.7	7.6	106	1.3
8.3	130	3.7	7.8	74	2.2
8.4	118	2.0	8.1	120	1.9
8.6	123	2.5	8.6	138	2.0
9.2	162	2.1	10.8	153	2.4
9.4	130	2.5	18.9	173	3.4
9.5	124	2.7			
10.0	155	2.5			
10.0	130	1.9			
11.9	160	3.9			

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