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AUTHOR Harmon, Lindsey R.
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ABSTRACT

Questionnaires were sent to U.S. high schools soliciting information on former students who had earned doctorates. The questionnaire provided data on grades, rank in graduating class, and mental test scores. The grades were summarized into four grade-point averages (GPA's), one each for English and foreign languages, social studies, mathematics, and science. Data on the PhD's (and their classmates) were compared by sex, by type of school, by size of graduating class, and by region of the country. The PhD's were also compared by year of doctorate and by field of specialization. Some of the conclusions are as follows: despite the massive increase in doctorate production, there has been no measurable change in ability level of the PhD's; the doctorate-holders are, on the average, one and one-half standard deviations above the mean of the general population in measured ability. A random sample of the girls graduating in the same classes as the doctorate-holders scored slightly lower than their male counterparts on standardized tests, but achieved better grades, particularly in verbalistic subjects. (Author/BB)

Scientific Manpower Report No. 6
20 August 1965

Research on Doctorate-Holders
Supported by the
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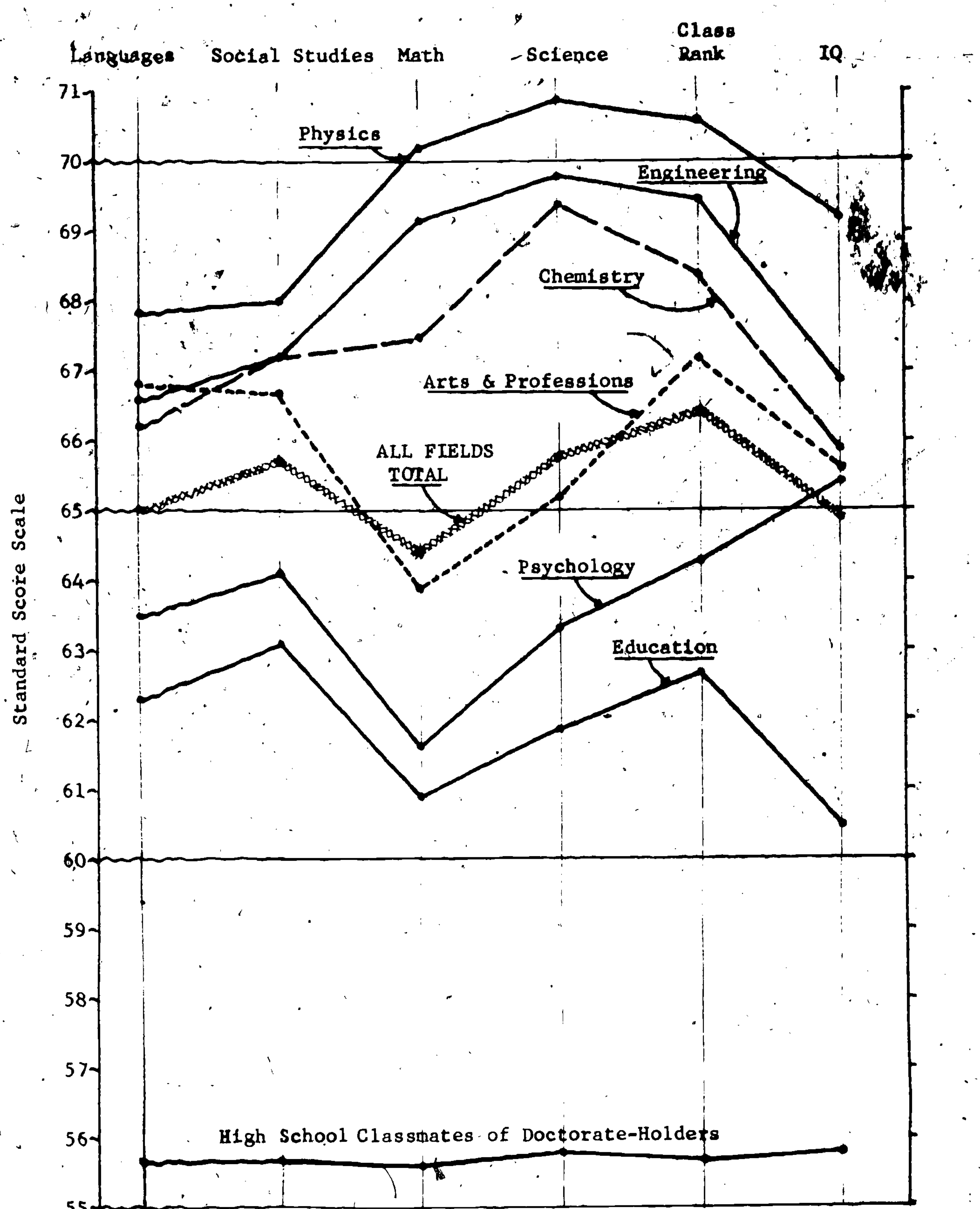
HIGH SCHOOL ABILITY PATTERNS
a backward look from the doctorate

by Lindsey R. Harmon

Office of Scientific Personnel
National Academy of Sciences--National Research Council
Washington, D. C.

PROFILES OF DOCTORATE-HOLDERS IN SIX FIELDS
And Their Non-Doctorate Classmates



PREFACE

The present study is one of several, including two previous ones relating to high school backgrounds, based upon the Doctorate Records File of the Office of Scientific Personnel. This extensive data bank has been the starting-point for studies of current doctorate production, of the baccalaureate origins of doctorate-holders, of the career patterns of doctorate-holders of various periods, of specialized groups of individuals drawn from the file, and of plans for post-doctoral employment of those currently graduating. An acknowledgement is therefore in order with respect to the basic data bank upon which all of these studies have been based.

The Doctorate Records File began about 1946 with support from the Carnegie Corporation and the Office of Naval Research, and included science doctorates of the period 1936-1945. It has since been extended, with support from the National Science Foundation, the Ford Foundation, and the Office of Education, to include all holders of third-level research degrees in all fields from all United States universities from 1920 to the present time. From a beginning in 1946 with fewer than 10,000 entries, it has grown to over 200,000. For each person listed, all earned degrees are noted, with their dates and the institutions granting them. The field of doctorate is also noted for all cases, and field of baccalaureate and master's degrees for some of them. For the graduates of 1957 and subsequent years, a great deal of additional information has been included by means of a questionnaire completed by each doctoral graduate just before or at the time of graduation. We are greatly indebted to the doctorate-holders themselves for providing this information, and to the deans of the graduate schools who have diligently collected the questionnaires and forwarded them to the Office of Scientific Personnel for subsequent processing. One of the items included from 1957 to the present time has been the high school of origin of each doctorate-holder. The two previous studies of high school backgrounds, supported by the National Institutes of Health and the National Science Foundation, included the graduates of 1957 and 1958. The present one, supported by the National Science Foundation, is much more massive in its coverage, and includes the doctoral graduates of the four years 1959 through 1962 inclusive.

For each of the graduates of the 1959-1962 period who named a United States high school as providing his secondary education, a questionnaire was prepared and sent to that high school. These questionnaires provided the school with information about the post high school education of their alumni who had attained doctorate degrees over the period concerned.

Each school was asked in return to complete a questionnaire regarding each of its doctorate-alumni, and also regarding a specified classmate of each doctorate-holder. This study could never have been accomplished except for the generous and unstinting help given by the high-school staffs in furnishing this information. We are therefore most particularly and directly indebted to the nation's high schools for providing the basic information included in this report, and are pleased to acknowledge this debt.

I am also indebted to Dr. John A. Creager for the statistical work involved in the multiple discriminant analysis reported in this study. Many others have contributed untold hours to data collection, coding and checking, and computer programming and operation. To all of these, who have provided the basic information upon which the study is based, I am also indebted. For any deficiencies in concept or execution, and for all interpretations of the results, I must bear responsibility. It is my hope that this study may enhance the interest which has been growing in recent years in the earlier education of the nation's most highly-trained manpower, and that it may lead on to further studies in greater depth and scope. Eventually, we may hope, an integrated picture may be obtained of the educational process and of its interrelations with the various other aspects of a many-dimensioned society.

L. R. Harmon

Lindsey R. Harmon
Director of Research
Office of Scientific Personnel

August 1965

Table of Contents

List of Illustrations

List of Tables

In Brief...

During the four-year period 1959-1962, 42,105 men and women earned doctorate degrees at U.S. universities. Of this number, 35,190 had graduated from 10,000 identifiable U.S. high schools, out of 25,000 high schools in the United States at the time. Questionnaires were sent to these schools, and 7458 schools replied, returning completed questionnaires on 23,980 PhD's, most of them with data also on randomly-selected classmates. From these returned cases, a representative sample of all U.S. doctorate-holders was chosen on the basis of regional distribution, type of school, and size of graduating class. This analysis sample of 20,440 doctorate-holders constitutes the basic group used in the present study.

The questionnaire provided data on grades, rank in graduating class, and mental test scores. The grades were summarized into four grade-point averages (GPA's), one each for English and foreign languages, social studies, mathematics, and science. Through the use of data on a representative sample of the classmates of PhD's, the four GPA's, class rank, and test score data were converted to uniformly scaled standard scores. Data on the PhD's (and their classmates) were compared by sex, by type of school, by size of graduating class, and by region of the country. Results are shown in a series of tables and graphic illustrations. The PhD's were also compared by year of doctorate and by field of specialization. A multivariate discriminant analysis was performed to determine how extensively the eventual doctorate-holders were differentiated at the high school level in terms of grades, course choices, and test scores. A number of conclusions from these researches are briefly stated at the end of the report, with page references to the text of the report where more extensive treatment of the question is to be found.

CHAPTER I: REVIEW AND PREVIEW

...1958 study highlights

The study of the high school backgrounds of the 1958 doctorate-holders developed a number of important facts. The mean general ability level, in terms of high school test scores, was found to be about 1.5 standard deviations above the mean of the general population, equivalent to an AGCT score of about 131. The doctorate-holders were, on the average, about one standard deviation above their classmates in general high school achievement, but there was no measure of the ability level of these classmates. There were marked field differences in ability as measured at the high school level by test scores, by rank in class, or by math-science grade point average. Marked geographic differences showed up in the relative frequency of doctorate attainment, and these differences were somewhat related to field of eventual doctorate. Size of high school graduating class was found to be strongly related to the probability of eventual doctorate attainment, classes of fewer than 100 being below-average in doctorate-attainment rate and classes of over 100 being above average, but with a decreasing advantage as class size passed 200. Very high productivity of the largest classes was found to be related not to size per se, but the fact that some of the largest schools, chiefly in New York City, were also selective on sex and on measured ability. One interesting fact relating high school environment to productivity was also discovered: on a state-by-state basis, and ignoring individual school variations within states, there is a positive relation between school retention rate through the 12th grade and eventual doctorate attainment rate. That is, those states with the fewest drop-outs were also the states which sent the highest proportion of their high school graduates on to the doctorate. High school graduation did not, therefore, act as an ability screen, but rather the reverse: the coarser the screen, the finer the results. Finally, it was found that the patterns of ability, of courses taken and avoided, and of math and science achievement, were sufficiently different for people in the five general fields of doctorate (physical sciences, bio-sciences, social sciences, arts, and education) that it was possible to sort about 40% of them into their eventual doctorate fields solely on the basis of the high school background information. Chance alone would have permitted a 20% success in predicting eventual field, so this information represented significant gain, showing in quantitative fashion that "as the twig is bent, so the tree is inclined." It left open, of course, what caused the twig to be bent.

...new study: aims and limits

These results, important as they might be, left as many questions as they answered. The present study, through the gathering of more extensive information and the refinement of experimental design, seeks to answer some of these. The questions which will be examined in the present report have to do with the capabilities and achievements of the doctorate-holders and their classmates. In the course of data collection for this study, additional information was gathered relating to the high schools themselves, which should permit in the future a more searching examination of the conditions in the high schools which are related to doctorate production, and perhaps to eventual field of doctorate. Only a brief look at these factors will be possible, however, within the limits of the current study.

Some of the questions arising from the study of the 1958 doctorate-holders, and from other sources, are spelled out in the paragraphs that follow. The general outline of the current study, its problems and methodologies, will then be described, and following that, the more detailed description of results, and final conclusions.

...the ability pool: dropping?

The output of doctorates by United States universities has climbed precipitously in recent years, from about 9350 in 1959 to 13,500 in 1963--an increase of 44% in four years. This has raised the question of where the talent can come from, if such a rate of increase is to be maintained. Must ability drop as numbers increase? The 1958 study had shown that of the students in the upper 2.5% of the ability spectrum (+2σ from the mean), only about one in 20 attains the doctorate. This would of course allow for a great increase in numbers without quality dilution. But what in fact had happened over the four-year period 1959-1962? Was the proportion of people in this ability range who attain the doctorate increasing or decreasing? Was the average ability level changing? The present study should provide some answers.

...field patterns?

Patterns of ability at the high school level had shown a relation to eventual doctorate field. With more extensive data, particularly in the fields of languages and social studies, could the differentiation of the five general doctorate fields be increased? Were there important sex differences in these ability patterns?

...what of peers?

The 1958 study showed how superior the doctorate-holders were to their classmates, but did not tell about the ability of these classmates. Could the new study provide some information on this score, and thus give a sounder basis for statements about the doctorate-holders? And just what, if any, were the differences between the classmates of people who eventually attained doctorates in different fields?

...double harness, help or handicap?

The 1958 study had shown sex differences in ability of doctorate-holders, with field held constant. Would these be confirmed? And what differences might be related to other characteristics, such as marital status at the time of the doctorate? Could ability patterns correlated with these factors furnish clues to a generalized statement of the relationship of aptitudes, opportunities, and eventual doctorate attainment?

...data mass up 800%

Satisfactory answers to all these questions required a much more massive undertaking than that involving the 1958 doctorate-holders. For one thing, a series of doctorate years was necessary in order to study time trends. It was also necessary to collect qualitatively different data, including grades earned in English, foreign languages, and social studies, rather than in math and science only, in order to get a broad-gauge picture of the whole achievement spectrum. It was also necessary to gather data somehow regarding the classmates of the doctorate-holders, if there was to be any evaluation of their significance. These considerations led to the general design of the present study, which is sketched below.

...H. S. origins: two schools in five

By the fall of 1963 there were available the doctorate graduates of the four years following the 1958 group, which had been previously studied. This would provide a sufficiently massive base for both time trends and investigation of the relatively small fields which could not be reliably examined on one year's output alone. Altogether in the four-year period 1959-1962 there were 42,105 people who received doctorate degrees from United States universities. About one out of seven of these had had his secondary education outside the United States, however, leaving about 36,000 from United States high schools. Not all of these high schools could be identified, but tentative identification was made of almost exactly 10,000 high schools which were the origin of 35,190 doctorate-holders from this four-year period. (There were in addition about 15,000 U.S. high schools who had no alumni among the doctorate-holders of this period.)

To each of these 10,000 high schools it was decided to send questionnaires regarding its alumni among the 1959-62 doctorates. This would provide the base data for the study. To furnish classmate data for comparative purposes and to provide a normative frame against which to measure the doctorate-holders, it was decided to ask the schools to furnish transcript data and test scores also for a classmate for each doctorate-holder. To insure that, as nearly as possible, such classmates would form a representative group, and also to keep the task (already enormous for the schools) to a minimum, the decision was made to ask for data regarding the classmate <u>alphabetically next after the doctorate-holder</u>. In most schools data on alumni are filed alphabetically, either by year or in a single alpha file for all graduation years.

..."You are to be congratulated..."

As partial compensation to the schools for the effort we were asking of them, it was decided to furnish to each school as much information about its graduates as possible, and to provide comparative data also, by which the school might assess its standing among other schools in the state, and, in the case of the leading schools, in the United States as a whole. Accordingly, each school was given a roster of all its doctorate alumni in our records, for 1957 and 1958, as well as 1959-62. The number of such doctorate alumni was compared with the corresponding numbers from all the other schools in the state, and the school's rank order given. There was in this information no indication of relative rate of productivity; that is, the size or nature of the school was not taken into account. It was felt that each school might best account for such factors for itself, in relation to the other schools in the area. In addition to this, each city school superintendent was sent a list of all the schools in his city that were included in our study, with a tally of the number of doctorate alumni from each, and the schools' rank orders within the state and within the U.S. where appropriate. It was found that the schools, and frequently the local newspapers were very interested in this information.

The questionnaires sent out to the schools with their doctorate alumni roster and other information were pre-printed forms upon which the name of the doctorate-holder, his high school name and date of graduation, and fields, years, and institutions of baccalaureate and doctorate degrees, were printed out by computer. Each questionnaire form asked for grades in all courses taken, and also for test scores and rank in graduating class. Additional information was sought on the questionnaire, and where appropriate from the city school superintendent, regarding the school itself and the community which it served. This information, not included in the present study, is available for later examination in order to answer questions about the school conditions related to doctorate productivity.

...three go out; two come back.

In all, the response rate to this questionnaire study was very satisfactory, although not up to the level experienced in the study of the 1958 doctorates. In that study, a 91% response rate was attained. In the current study, the response rate dropped to 68%, largely because the very volume of information requested was beyond the capacity of some of the schools to supply. This was particularly true of some of the largest and most productive schools. The manner of compensating for less than 100% response rate is described a little later in this report. Suffice it to say here that it was found possible to draw from the 68% of cases upon whom information was furnished by the 7458 responding schools, sufficient data to make a report without apparent bias due to the failure of complete response.

CHAPTER II: METHODOLOGICAL CONSIDERATIONS

To permit an advance over the study of the 1958 doctorate-holders, it was planned to set up a more rigid frame of reference for the current study, tied more closely to general parameters derived from the base doctorate population and from the general population. Two procedures were employed to this end. The first involved selection from the questionnaire returnees of a sample that would be more representative of the base population than was the raw total of all returnees. The second procedure involved setting up a normative base derived from the classmates of the doctorate-holders and from a measurement of the extent of the deviation of this classmate group from the general population.

...to check on bias

Whatever the return rate, whether above 90% as in the 1958 study or below 70% as in the current study, it could not be assumed that the returns were equally representative of all sections of the whole doctorate population. A high response rate, as in the earlier study, reduces the area of possible bias, but does not eliminate it. A response rate of 68% strongly suggests the advisability of a careful check of response bias.

...no "shrinking violets" here

One fortunate fact in a study such as this one is that the response is from schools, not individuals. Individual characteristics are therefore not reflected directly in the response rate, as is frequently the case. We are free of the bias which results because a given individual does not feel that his own results count, a bias that in other studies tends to selectively diminish return rates from the less successful, or those who consider themselves less successful. School policy variations, or variations in the resources needed by the schools in order for them to prepare the returns, tend to affect results seriously. It is therefore necessary to set up criteria which would reflect school characteristics but ignore individual characteristics, in order to trim out from the raw returns a sample that would be reasonably representative of the whole doctorate population.

...planing off the bumps

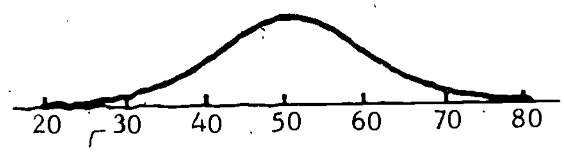
The method of sample-trimming used was as follows: a three-dimensional table was set up on the basis of the school characteristics of that portion of the whole 1959-1962 doctorate population which came from United States high schools. The three dimensions of the table were geographic region, type of high school, and graduating class size, all parameters available from the original Doctorate Survey. There are nine geographic regions, three school types (public, denominational, independent) and eight class-size categories. These three dimensions yielded a table with 216 cells (9 x 8 x 3 = 216). The proportion of the whole doctorate population in each of these 216 cells was determined, and formed the basis for elimination of cases in cells with disproportionately high return rates. It was estimated that if no cell had more than 60% of the number in the base population for that cell, the resulting total accumulation from all cells would be reasonably representative; few cells would be seriously under-represented and the analysis sample would still be large enough for reliable results. Accordingly, "excess" cases beyond this 60% quota were eliminated by a random process from each cell. The necessary random numbers were determined by reading in reverse order the middle four digits of a six-digit alpha-serial number. This process could not, of course, build up numbers in the "deficient" cells, but it could reduce the number of cells with significant deficiencies. As it turned out, the analysis sample was reduced by this process from 23,980 cases to 20,440, and only 51 cells out of the 216 were deficient, by a total of 230 cases--less than one tenth of one percent.

...a minimax solution

The deficient cells tended to be concentrated in the schools of smallest class size, but were not limited to this group. The solution found by this step was near-optimal, in that further pruning to eliminate other deficiencies would cut down too far on the total number of cases remaining for analysis. Although the total number of 20,440 is very large, in some of the field breakouts, or for combination break-outs of various sorts, this would not leave very large numbers in some of the less populous categories. It was therefore decided to go ahead with the working sample thus provided. Appendix A provides a three-fold table showing the distribution of the working sample by region, by school type, and by size of graduating class.

...a level base-line needed

The second problem concerned the use of the classmate data to establish a normative frame within which further analyses could be made of patterns of data concerning either the classmates or the doctorate-holders. Six quantitative measures, described in the following chapter, were available. Not all of them were available on every case, for a variety of reasons. The six variables are: grade point averages in the four subject-matter areas of English and foreign languages, social studies, mathematics, and science; normalized rank in class; and intelligence test score. The desideratum from the standpoint of statistical analysis is that there be a scale system sufficiently consistent linking these six variables so that patterns of ability on them may become apparent. A given scale value should have the same normative interpretation from one variable to another so that any patterns that show up may relate to the nature of the variable rather than be an artifact of the scale system. The idealized average person would, on such a set of scales, have a perfectly flat profile.



The scale system used here was the standard score scale familiar to psychometricians for a generation. The average score is 50, the standard deviation is 10. The normal range of scores on such a scale is from about 20 to about 80; only a few extreme deviates will have scores beyond this range. In the present study, which deals with a highly-selected population, scores up to 85 will be expected to occur occasionally. The top score was therefore set at 85; the low end of the scale will not be of serious concern here. It might be mentioned in passing that this is essentially the same scale used in reporting the results on the 1958 doctorate group: The AGCT scale is exactly this scale multiplied by 2.

...select and calibrate

In brief, the scaling technique involves selection of a sample from the classmate group that would be as representative as possible of the whole set of classes from which the doctorate-holders came, and then computation of the mean and standard deviation of each of the six variables to provide a base for the calibration of the standard score scale.

...normal = 10% in each decile

One of the six measures available on most of the doctorate and classmate cases was rank in graduating class. The procedure for obtaining the classmate sample was designed to make this group as nearly representative as possible. This ideal was not quite achieved, however. When the percentiles were computed and tabulated, it was found that the sample was slightly weighted toward the higher deciles. Some schools had either not reported the classmates when they turned out to be very poor students, or had substituted someone with higher grades. To correct this imbalance, a procedure analogous to that employed on the doctorate sample was used. The classmates were distributed by region and by decile within region, and cases trimmed from each region-by-decile cell until a balanced total was obtained for the United States as a whole. "Balanced" here means that the distributions were symmetrical, with as many above as below average. There remained, however, a minor piling up in the middle deciles, and thinning out of the extremes. The net effect of this abnormality (a mild leptokurtosis) is shown in a reduction of the standard deviation of the normalized rank in class from the theoretical 10.0 to 9.7. It was not possible to achieve a balanced distribution for each region, although no serious regional imbalances remained. The final result, in terms of a decile-by-region table, is shown in Appendix B.

...profile flat within .01 σ

Once the standard classmate sample was selected, the construction of the standard score scales was relatively straightforward. The mean and standard deviation of the standard sample was computed for each variable, and all means adjusted to the mean test score, as the intelligence test measure furnished the only link to the general population parameters. It was assumed that the original test standardization was properly done and that the conversion table used in this study and with the 1958 doctorates was adequate. On the test score variable, the standard classmate sample had a mean standard score of 56.77. The means on the five achievement variables were therefore adjusted to this standard by adding 5.6 to the normalized rank, 1.0 to the mathematics GPA, and subtracting 2.0 from the social studies GPA. The result was a baseline of the six variables which did not deviate more than 0.1 from the average of the six. This was sufficiently accurate for the purposes of the present study.

...aim: six uniform measuring-sticks

For analytical work involving particularly a deviate group such as the doctorate-holders, it is necessary to erect on this flat base-line a set of scales with approximately equal scalar units. This was done by consideration of the standard deviations of the classmate sample on the six variables, which, with corrected means, were as follows:

	GPA 1 Languages	GPA 2 Soc. St.	GPA 3 Math	GPA 4 Science	Normalized Rank	Test Score
Corrected mean	55.7	55.7	55.6	55.8	55.7	55.8
Standard deviation	16.3	16.8	18.6	17.5	9.7	9.3

The conversion from the original GPA scores to the standard scores is accomplished by the formula:

$$\text{Standard Score} = \frac{10\,(x - c)}{\sigma} + c$$

where x = a given original GPA score
c = the corrected classmate mean for that GPA
σ = the original standard deviation

As a practical measure to facilitate conversion of the computer-produced data, which were in terms of the original variables, a set of conversion scales was constructed; these tables are given in Appendix C. Only the GPA's, which were set up within this study by operational definitions determined for this study, need such correction; the normalized rank and test score variables were used as found, except for the addition of 5.6 to normalized rank to equate it with the test score variable. The result of these operations is a set of scales by which deviations from a theoretical general population base (that of the test standardization) may be measured in units based on the spread of ability within a representative sample of the classmates of the doctorate-holders. While far from perfect, these scales will suffice to show up patterns of ability where such patterns are pronounced enough to have any practical significance.

CHAPTER III PROCEDURES AND VARIABLES

The first portion of this chapter describes the procedures that were used in the mail-out of the data, and its processing on return. The last portion describes and defines the variables used in the remainder of this report.

...questionnaire pre-tested

The first step in the data-collection procedure was to send to a group of high school principals who had cooperated in the study of the 1958 doctorates a draft copy of the procedures to be used, and draft copies of the questionnaire to be employed, referring to their 1958 doctorate alumni, with a request that they try it out, and comment critically on its practicality. On the basis of their comments, some changes were made in the form and procedures, and the questionnaires sent for printing.

...an IBM school directory

In 1952 the U.S. Office of Education published its first complete Directory of Secondary Day Schools in the United States. An earlier directory, published in 1949, was somewhat short of complete. The IBM cards used in the preparation of the 1951-52 directory were secured, and provided the basic data for the later operations of assigning school identification numbers, printing address labels, and printing out a roster suitable for the coding procedure. Most of the PhD's in the present study had graduated from high school before 1950, and the schools of almost all of them could be identified in the 1951-52 directory. Where errors in identification were made, they were frequently corrected when the forms were returned by the high schools as not belonging to them. In a few cases it was not possible to identify the high school of origin; this was a negligible source of loss in the present study, however.

...a computer process

The identification of the high school of origin of each doctorate-holder was established by means of the questionnaire which he had completed at the time of his doctorate graduation. This also provided the date of high school graduation. This information, plus his year and place of birth, as well as the institution, date, and field of his bachelor's and doctor's degrees, were extracted by computer processes from the Doctorate Records File of the Office of Scientific Personnel for print-out on prepared forms to be sent to the high schools. To do this, however, the records had to be assembled by high school of origin. In order to provide rank within state (for those with five or more doctorate alumni) and rank in the nation (for those with ten or more doctorate graduates), the data then had to be analyzed statistically. The assembly of each school's alumni involved a coding process in which a four-digit school code number was assigned to each high school which, together with the two-digit state identification used throughout the Doctorate Records operation, provided a unique code number for each school. The first digit of the state code identifies the state's general geographic region.

...the mail-out packet

When the computer operation was completed, it was found that, in all, 35,190 questionnaires were mailed out to almost exactly 10,000 high schools out of the 25,000 in the United States in 1952. A cover letter adapted to the number of doctorate alumni from each school was sent out with the questionnaire, together with a printed roster of its doctorate alumni and information on rank of the school in the state and nation where appropriate. Each school was also sent reprints of the previous reports based on the study of the 1958 doctorate-holders so that they might see what results had been achieved from the previous study, and how the data would be used in the current study. To each "state champion" high school (the one with the largest number of doctorate alumni in the state), and to each school with over 100 doctorate alumni, a special letter was sent. These schools were also sent a copy of NAS-NRC Publication 1142, "Doctorate Production in U.S. Universities, 1920-1962." A copy of this book was also sent to each of the large-city school superintendents. It was felt that the information in this book would be of particular value to the educational systems which were the major secondary-school sources of these doctorate-holders, and to their students. It was also hoped that this book might serve as a minor recompense for the extra effort required of these larger schools. A sample of the questionnaire used, of the cover letter employed, and of the information sheet sent to each school regarding its doctorate alumni is included in Appendix D.

...follow-up

Although it had originally been planned to mail out the questionnaires in early October, the data-processsing requirements delayed mail-out until late November 1963. Replies came in over the succeeding months, and some even in the following summer and fall. As they were received, they were tallied on a roster of all schools involved in the mail-out. It became apparent from this tally and from letters received in reply that returns were best from the middle-sized schools, poorest from the schools with one doctorate alumnus only, and deficient also from the largest schools. In the spring of 1964, a follow-up letter was sent to all non-respondent schools with more than one graduate in the 1959-62 doctorate group, followed in the fall by a similar effort for the schools with one graduate only. Special efforts as seemed appropriate were made in the big cities with small response from some of the largest schools. These efforts in part redressed the imbalance in response rates from schools of various sizes and types, but, as noted in the chapter on methodology, further "trimming" of the response sample was necessary before data analysis could begin.

...log in → code → check → punch → compute → wri

Some of the schools replied by transcribing the students' data to the questionnaire forms that had been sent; others sent photo-transcripts. In the case of the latter, the necessary transcription was made in the Office of Scientific Personnel, so that all data would be in uniform format for further data processing. Each form was then coded, and the coding checked by a second coder to insure maximum accuracy. This information, as may be seen by examination of the questionnaire form in Appendix D, includes not only the individual's grades in the various subjects, but also information about the school and the community. In the case of the large cities, the schools were instructed to omit this information; it was sought directly from the office of the superintendent, to save transcribing it to each individual form. Some of the superintendents did not respond to this inquiry; the data regarding schools is therefore still incomplete and is not included in this report. At relatively small expense, it is believed, it could be completed and a further study made of the inter-relations of individual data, school operating conditions, and relative productivity, using the data from the U.S.O.E. Directory cards as a base for computing number of doctorates per 100 graduates, etc.

...four GPA's computed

The school subjects are grouped on the questionnaire form into five subject-matter areas: English, foreign languages, social studies, mathematics, and science. Although grades in each individual subject could be studied if desired, it seemed more logical to group them into general areas and compute a grade point average for each area, to reduce the complexity of the data and increase reliability of the results. Because a great many students did not have any foreign language, and because it is to be expected that the correlation between foreign language grades and English grades is substantial, all language grades were combined into a single grade point average (GPA). Similarly, all social studies were grouped into a social studies GPA, and GPA's computed also for math and for science--four in all. The computation of GPA's was done by computer after the information had been coded, punched, and transferred to a magnetic tape record. The original coding, however, was done by hand according to the following scheme, in which letter grades (or numerical grades where they were used) were transcribed to a uniform base:

Code Scale	Letter Grade	Numerical Grade
9	A	93 +
8	AB, A-, B+	89-92
7	B	85-88
6	BC, B-, C+	82-84
5	C	78-81
4	CD, C-, D+	74-77
3	D	70-73
2	DF, D-	65-69
1	F	Below 65

Where schools used a numeric grading system different from the above, they were asked (see bottom of the questionnaire form) to state what it is, so that proper account could be taken of the variation. It was, of course, impossible to take into account the school variations in the meaning of an A or B or C in a given course; as will be seen in the next two chapters, there were school differences in grading standards. By using the uniform code scale shown above, it is possible from the present data to make studies of the quantitative differences among schools and various categories of schools in the grading systems employed. The GPA's as they stand must reflect the local grading requirements, however.

...from percentile to standard score

Each school was asked to indicate the rank of each student, doctorate-holder and classmate, among the other members of his graduating class. In some cases, only a decile or quintile or quartile standing was indicated. In most cases, however, the number of students in the class, and the graduate's relative rank were indicated. This information was fed into the computer, and a percentile rank computed. It was then transformed, by a table look-up program, into a "normalized rank" score, using the standard tables relating the percentile position to standard score in a normal distribution with a mean of 50 and standard deviation of 10. This normalized rank score is, of course, closely correlated with the average of the four GPA's, but has merits the GPA's do not possess, as described in the chapter on methodology.

Finally, the schools were asked to provide information on standardized intelligence tests. There are of course a very large number of such tests in use, and there is no cross-standardized system to relate an IQ on one test with an IQ on another. In the absence of such a national standardization system, all data that could be collected regarding variations in the statistical meaning and interpretation of the various tests was assembled, and used to cast all of them into a uniform framework, using the standard score system with a mean of 50 and standard deviation of 10. The scaling system used was the same as that used previously in the analysis of the 1957 and 1958 data. A copy is in Appendix E. No claim can be made as to the degree of its accuracy; its uniformity insures that there will be comparability of data across any groups compared by means of this transformation chart; because of the essentially random nature of geographic spread of the various tests, and the fact that all tests are used in all types of schools and for all eventual categories of doctorate-holders, no bias could be introduced into the final results by any imperfections which may exist in the test coding chart as it stands.

CHAPTER IV CLASSMATES AS A NORMATIVE BASE

The general procedure for use of the classmate cases as a normative base for the further study of the doctorate-holders has been explained in Chapter II. The present chapter elaborates somewhat further on the data from the classmate group and the implications of the patterns found there.

...snap course, tough course

The first point worthy of note is the pattern on the original uncorrected GPA's that required a correction to the mean scores. The social studies GPA was two standard score points above the general average; the mathematics GPA was one point below the general average. This represents variations in grading standards in the courses involved, and could be briefly stated, perhaps in oversimplified form, in the terms the students might use: "social studies is a snap; math is tough". There are of course tremendous variations from school to school and within schools from course to course or teacher to teacher; the results here are merely the over-all summary from thousands of schools across the whole country. It would be possible, but seems unnecessary for the present purposes, to sort the data out further into individual courses involved in the various GPA's, and tabulate ability levels, as measured by the standardized tests, for those who took the courses. It might well be found that the students who took several mathematics courses, for example, were more able than the students who had several social studies courses; this would, if found, indicate that an even further correction would be in order. In this manner, it might be possible to learn a great deal more from the present data about the characteristic variations among courses and school grading standards in the United States, always keeping in mind that the present sample is not representative of all schools, but only those schools which were the origin of doctorate-holders.

...the sexes differ in achievement

Among the results that are of interest in themselves, apart from what they contribute to the study of doctorate-holders, are findings regarding sex differences in high school achievement and test score. The data given below are in terms of corrected standard scores, for boys and girls among the classmates, and indicate the number of boys and girls in each group, and the percentage of the total group upon whom each GPA was computed.

Table 1

Number of Cases and Corrected Mean Standard Scores on Six Variables By Sex, for the Classmates of Doctorate-Holders

	GPA 1 Language	GPA 2 Soc.St.	GPA 3 Math	GPA 4 Science	Normalized Rank	Test Score
Mean of Girls	58.4	56.6	56.8	56.9	57.4	54.9
Mean of Boys	53.6	54.[illegible]	54.7	55.0	54.4	56.5
Number of Girls	4776	4765	4292	4544	4780	3418
Number of Boys	6042	6012	5799	5857	6051	4283
Percent Girls	99.91	99.68	89.79	95.06	100.0	71.50
Percent Boys	99.84	99.35	95.82	96.79	100.0	70.78

The above table shows rather dramatically the now familiar fact that girls tend to be superior in verbal performance, while boys compete on more nearly equal terms in math, science, and social studies. The difference in rate of occurrence of math and science GPA's is significant also. Practically all students, boys and girls, have GPA's in languages and social studies, presumably because at least some courses in these subject areas are universal requirements. Not so with mathematics. One girl in 10 has no math courses, and one in 20 no science courses, while among the boys these ratios are one in 24 and one in 31, respectively.

...boys' schools, girls' schools

In Table 1 above, the boys are superior in measured intelligence and the girls in normalized rank. This is in part due to variations in school type, and selectivity, which will be dealt with in greater detail later. That is, boys are more likely to be sent to specialized, selective schools, and the graduates of these schools, in part because they are boys, are more likely to attain doctorate degrees. Consequently, the schools from which they graduate are more heavily sampled in the present study with the result that, although the present cases are randomly selected from among their classmates, they are differentially representative of schools with the indicated selective admissions policies. It seems probable, however, that the observed sex differences are also due in large measure to the fact that girls tend to perform in the classroom in ways more likely to earn good grades in the typical high school. Boys are less conforming and docile, and are in greater measure punished for these deviations with lowered grades.

...more boys drop out

The effects of differential drop-out rates are not directly apparent in the data of the present study. In general, boys are more likely to drop out before completing high school than are girls, and it is for the most part the less able ones who drop out. This would produce a higher mean measured intelligence for high school graduate boys than girls. However, in the present study, we have found more boys than girls among the classmates, because of the sex-segregation policies of some schools, both public and private, and the fact that boys' schools are more heavily represented here. It is not immediately apparent how these two selective trends can be disentangled within the limits of the present study. The results as observed, however, are in accord with the expectations from differential drop-out rates; the measured intelligence of the boys among the classmates is higher than among the girls, in spite of the boys' lesser earned grades.

It is instructive to compare the profiles of the boys and girls by type of school, and in the next chapter, to compare these profiles with those of doctorate-holders similarly sorted out. Table 2 provides the essential data.

Table 2

Means of Boys and Girls, and Sex Differences on Six Variables, By Type of School

Sex	Type of School	GPA 1	GPA 2	GPA 3	GPA 4	Rank	Test
Girls	Public	58.4	56.6	56.8	56.9	57.6	54.8
	Denominational	58.0	56.9	56.2	56.4	55.3	54.3
	Independent	58.5	57.3	56.5	58.2	55.7	58.2
Boys	Public	53.3	54.6	54.6	55.1	54.2	55.6
	Denominational	54.9	56.3	54.6	54.2	54.9	57.8
	Independent	53.9	55.2	55.2	54.8	55.3	61.7
Diff., G-B	Public	5.1	2.0	2.2	1.8	3.4	-0.8
	Denominational	3.1	.6	1.6	2.2	.4	-3.5
	Independent	4.6	2.1	1.3	3.4	.4	-3.5

The girls in all three types of schools are consistently higher in achievement--especially in languages--than the boys, who are consistently superior in measured aptitude. In the public schools the superiority of the boys in tested ability is less than one point; in both types of private schools it is 3.5 points. As a consequence, the girls are just barely superior in normalized rank in the private schools, but superior by over three standard score points in the public schools, as is shown in the bottom portion of Table 2.

When data for the boys and girls are combined, the following mean scores are found for normalized rank and test score for the three school types:

	Normalized Rank	Test Score
Public Schools	55.8	55.2
Denominational Schools	55.0	57.0
Independent Schools	55.3	61.2

This table brings out most clearly the selective admissions policies of the private schools in this sample, particularly in the independent group. The slightly lower normalized rank mean of the private schools may be an indication that a higher proportion of their graduates may have gone on to the doctorate, so that a larger fraction of all schools in the private sector are included in this study than is true of the public schools. A determination as to whether or not this has actually occurred must await a later study.

...field differences?

The "classmate cases" were sorted out by the field of eventual specialization of their matching doctorate-holders. This was done to check on the possibility that differences in the educational milieu, as represented by the high school peers, might be influential in eventual field choice. Differences in ability among doctorate-holders had been clearly demonstrated in the study of the 1958 doctorates, with AGCT-equivalent means ranging from 140 for the highest-scoring field down to 123 for the lowest-scoring field. Were those in the high-ability field selected more frequently from among high-scoring classes, and vice versa? This was readily checked, and the results were negative with respect to measured intelligence, normalized rank in class, and the four grade point averages. Corrected means on these six variables for the classmates of doctorate-holders in the several fields are given below in Table 3.

Table 3

Corrected Means of Six Variables on Classmates of Doctorate-Holders in Ten Fields of Specialization

Field	GPA 1 Language	GPA 2 Soc.St.	GPA 3 Math	GPA 4 Science	Normalized Rank	Test Score
Math	56.3	56.0	56.0	56.5	56.1	56.7
Physics	55.9	55.7	55.5	55.8	55.9	56.0
Chem.	55.5	55.2	55.3	55.5	55.7	55.4
Geo-Sci.	55.5	55.8	56.2	55.8	56.1	55.9
Engin.	55.9	56.0	55.6	55.7	55.9	55.8
Biol.	55.6	56.0	56.0	56.1	55.9	55.2
Psych.	55.4	55.8	55.2	55.7	55.8	57.0
Soc.Sci.	55.4	55.7	55.7	55.7	55.4	55.6
Arts	55.3	55.4	55.1	55.7	55.3	56.2
Educ.	56.0	55.6	55.8	56.0	55.8	55.4
Total	55.7	55.7	55.6	55.8	55.7	55.8

Whether there is any relation between field of eventual specialization and predominant sex of classmates (largely a function of special rather than coeducational schools) was also explored. The percentage of males among classmates, and the standard errors of these percentages, by field, are shown in Table 4 below.

Table 4

Percentage of Boys among the Classmates of Doctorate-Holders By Field of Doctorate, with Standard Errors of Percentages

Field	Percent Males	Field	Percent Males
Mathematics	57.5 ± 2.7	Biology	54.9 ± 1.2
Physics	56.9 ± 1.8	Psychology	57.6 ± 1.5
Chemistry	56.0 ± 1.3	Social Sciences	59.6 ± 1.4
Geo-Sciences	62.8 ± 3.0	Arts & Professions	55.2 ± 1.3
Engineering	56.2 ± 1.5	Education	51.0 ± 1.3

General Average = 55.9%

The fields of geo-sciences, social sciences, and education differ significantly from the mean percentage for all fields combined. This may be in part a function of type of school, as other studies (see Scientific Manpower Report #5, 18 Jan. 1965) have shown that educators come predominantly from public schools, and in this sector, disproportionately from the smaller schools, few of which are segregated by sex. It is also true that percentage of females among education doctorate-holders is high; to the extent they come from girls' schools, the percentage of males among the peers of the education group would be lowered. Social scientists come disproportionately from denominational and independent schools, and from large-city public schools, which are segregated by sex more frequently than is true of the medium-size public schools. The high proportion of males among the classmates of geo-scientists cannot be explained so readily in terms of type of school, as this group also comes disproportionately from public schools, with an average percentage from independent schools and an unusually small percentage from denominational high schools.

...size and type of school

Ability variations by size and type of school are shown by the following table, which includes numbers of cases, corrected means on normalized rank, and intelligence test mean values. In the largest and smallest size categories the numbers of cases from the private schools, both denominational and independent, are too small for reliable statistics; all size categories above 10 students per graduating class have been retained nevertheless in order to compare data for the public schools of various sizes. Variations in means of normalized rank occur by both size and type of school because these factors were ignored in selecting the representative sample of cases (only region and percentile rank were explicitly considered). Because type and size of school are related, as are also type and region, there are some rather complex interactions which may have made the private school cases of both types somewhat less representative of their own base population than are the public schools which form the great bulk of the cases. This caution should be kept in mind in any interpretation of the patterns found in Table 5.

The over-all variations in normalized rank (see column for "all types"), as one reads down Table 5 from the smallest to the largest schools, amount to three points in standard score (.3σ), half of it in the first step. This is probably due

Table 5

Corrected Standard Score Means on Normalized Rank and Test Score by Size and Type of School

Size of Graduating Class	Normalized Rank				Test Score			
	Public	Denom.	Indep.	All Types	Public	Denom.	Indep.	All Types
1-19	53.5	55.0	52.5	53.6	54.2	57.5	57.5	55.3
20-39	55.8	54.6	53.9	55.3	54.0	56.2	60.0	55.7
40-59	54.8	55.2	55.9	55.0	52.8	56.9	60.4	54.7
60-99	55.4	54.4	55.9	55.3	54.5	56.1	59.4	55.3
100-199	56.0	54.7	58.0	56.0	55.8	57.7	64.2	56.0
200-499	56.0	56.2	53.3	56.0	55.6	57.5	64.8	55.9
500 & up	56.4	55.4	51.1	56.4	56.3	55.6	61.0	56.3
Total, all sizes	55.8	55.0	55.3	55.7	55.2	57.0	61.2	55.8

to the fact that the PhD-holder is generally from the upper part of the class (typically one σ above the mean; only one out of 8 from the lower half) and that his elimination leaves selection of a classmate from a remainder of lower average rank. In the larger classes, this occasional elimination has small weight; in the classes smaller than 20, and particularly smaller than 10, it has a marked effect. This probably accounts also for the lower over-all normalized rank means for the private schools; small classes are more typical for them than for the public schools. There seems to be no significant trend in the normalized rank variable except for the classes of fewer than 20. As mentioned earlier, the values for the private schools in the smallest and largest categories are unreliable because of the small number of cases.

...urban = verbal?

The relation of intelligence test score to class size is weak but discernible, and in the expected positive direction, particularly for the public schools. A rural-urban difference in intelligence test scores has been repeatedly observed over the past 40 years, and undoubtedly explains the class-size differential. In each class size category for which reliable data are available, the denominational school mean is higher than that for public schools, and the independent school mean highest of the three types. Whether the schools sampled in the present study are equally unrepresentative of all three types of high schools cannot be immediately determined. In all, the original returns represented a sampling of 7458 schools out of 25,000; the reduced sample used in the tabulations here includes about 4000 schools or 16% of the national total. Generalization to the whole set of schools of any type would therefore be unwarranted on the basis of presently-available control data.

...regional patterns

Table 6 below gives data on normalized rank and test scores by geographic region. Variations in normalized rank are small, in spite of the fact that it was necessary to eliminate selectively from some regions more than from others to minimize the loss from the regions of lowest total response rate, and the further fact that eliminations were from the upper half of the ability range. The "penalized" regions (principally the northeastern regions) have scores as high as the others. One interpretation of this fact, and a pleasant one to make, is that the trimming was in fact effective in eliminating "surplus" cases from categories that were originally over-represented. The results indicate as a minimum that the several regions are, on the average, fairly represented.

In intelligence test means, the regional variations follow a familiar pattern, with the heavily urbanized northeast regions scoring highest and the rural areas scoring lowest. The somewhat lowered mean for the Pacific area is probably due to the fact that most of the city of Los Angeles was omitted. Only few classmate records were received from that city, although data on the doctorate-holders from Los Angeles were furnished by its Central Records Bureau.

Table 6

Normalized Rank and Intelligence Test Mean Scores by Geographic Region

Normalized Rank		Test Score
55.6	New England	56.6
55.8	Middle Atlantic	56.8
55.7	East North Central	55.5
55.3	West North Central	54.6
55.6	South Atlantic	55.3
55.9	East South Central	52.7
55.7	West South Central	55.5
56.1	Mountain	55.5
56.2	Pacific	54.9

CHAPTER V THE DOCTORATE-HOLDERS

All the preceding chapters are prologue. Major interest centers on the doctorate-holders. Two chapters will deal with this subject in somewhat different fashion. This chapter will deal with patterns of scores that can be visually compared. The next will deal with a much more sophisticated statistical comparison of patterns, utilizing a multiple discriminant analysis to distinguish maximally between various fields of eventual doctorate on the basis of high school data. The paragraphs below describe the techniques of insuring that the visualized patterns found in this chapter represent realities of the data and not artifacts of procedure. This description is partially redundant on Chapter II, which described methodology; it is presented here in a somewhat different form to facilitate understanding of the process.

The corrections used with the classmates to remove average differences in the four GPA's are supplemented to correct for variations in the standard deviations, or spread of the scores above and below the mean. The illustration below for GPA 1, languages, shows the successive steps which are condensed in the formula given in Chapter II.

70.81 from the original mean of the doctorate-holders is subtracted
-55.65 the original mean of the classmates. This gives the
15.16 difference in original scale points.

Dividing this difference by the standard deviation of the classmates,
15.16 ÷ 16.27 = .932 we have the mean of the doctorate-holders expressed in units of the standard deviation of the classmates. As the standard score scale divides the standard deviation into ten points, we multiply this value by 10 and add the classmate mean,

9.32 + 55.65 = 64.97, rounded to 65.0

to get the corrected grand mean of the doctorate-holders in standard score terms, for GPA 1.

A similar procedure was used with the other GPA's, with the addition of the corrections for subject-matter differences, discussed in Chapter II, which subtract two points (2.0) from the social studies scale and add one point (1.0) to the mathematics scale. The result is four corrected GPA's, as follows:

GPA 1 Languages	GPA 2 Social Studies	GPA 3 Mathematics	GPA 4 Science
65.0	65.7	64.4	65.9

As noted in Chapter II, the procedures described above were used to produce conversion tables from the original scale GPA's to the corrected standard score scales. These tables are reproduced in Appendix C. All of the data in the rest of this chapter will be in terms of these standard score scales. A standard profile is completed with the addition of two more variables: the test standard score and the normalized rank, corrected by adding to the original score 5.6 points to minimize the difference between the test scale and normalized rank scale. It is this corrected normalized rank score which will be used in all subsequent tables.

The full profile of six variables for the doctorate group is not as flat as that of the classmates, for a number of reasons, at least a few of which are known. (Many other causes of variation no doubt exist, including inaccuracies of the scaling technique.) The profile of the entire doctorate analysis group will be used repeatedly in what follows as a frame of reference against which to evaluate the profiles of a number of sub-groups. It therefore deserves some examination at this point. The six-point doctorate profile is as follows:

GPA 1	GPA 2	GPA 3	GPA 4	Rank	Test
65.0	65.7	64.4	65.9	66.5	64.9

The fact that the normalized rank standard score is higher than the average of the four GPA's (from which, in essence, it is drawn) is predictable on the basis of statistical regression. This may best be understood by considering a set of students who attain "A" grades in various subjects. Of all those who have "A" in English, for example, some will have "B" or "C" in trigonometry, history, or chemistry, while those who have "A" in trigonometry will include some who have "C" or "B" in the other subjects, and so on. The student who has two "A's" is rarer than one with a single "A", and therefore statistically has a higher percentile ranking. Likewise those with three and four "A's" are still rarer, and would have still higher percentiles, which would of course convert to higher standard scores. Viewed from another angle, one could say that if a given letter grade had a constant meaning in percentile terms, a student who scores 4 A's and 2 B's on weekly examinations would have an A as a six-week average, not A- as might be supposed. So with the doctorate-holders as a group; they are superior students, on the whole, but not with entire consistency. They are not "straight A" students. They slip up here and there in one subject-matter area or another. But when the grades of a generally-superior group such as this are collected into one over-all grade point average, and this over-all score is interpreted as a normalized rank, they will be more outstanding on the normalized rank than would be shown by a simple averaging of the scores on the separate components.

...profiles, profiles, profiles

Using this generalized profile as a basis of comparison, we will examine the data by year of graduation; by sex; by marital status at time of PhD; by school size, type, and location; by field of specialization for the doctorate; and by various combinations of these factors. In general, the simpler comparisons will be made first, proceeding gradually to the more complex ones.

Fears that the increasing number of doctorates represents a dilution of quality seem quite unwarranted on the basis of the data for the time trend--or lack of trend over the four years of this study, as shown below in Table 7.

Table 7

Ability Profiles of Doctorate-Holders by Year of PhD

Year of Doctorate	GPA 1 Language	GPA 2 Soc.St.	GPA 3 Math	GPA 4 Science	Normalized Rank	Test Score
1959	65.0	65.6	64.4	65.7	66.5	64.9
1960	64.9	65.5	64.2	65.7	66.4	65.0
1961	65.1	65.9	64.4	65.8	66.5	64.9
1962	65.0	65.7	64.5	66.1	66.4	64.9

Variations in the pattern of the GPA's are small and inconsistent. The variations in measured ability and in normalized rank, which are the best over-all indicators of general ability, show absolutely no trend over the four years of this study. A direct comparison with the previous studies of 1957 and 1958 doctorate-holders cannot be made without going back to the data for those years and selecting samples in the same manner as the samples were selected for the current study. As noted in the chapter on methodology, the 20,440 cases in the present study were selected to be representative of the whole doctorate population by region, school type, and school size. The data published for the 1958 doctorate-holders were unselected, and certainly represented the large, highly selective schools of the metropolitan areas more heavily than the smaller schools, and the north and east more strongly than the southern and mountain areas, where the test scores tend to run lower. Therefore, no comparison with the earlier years will be attempted at this time; the data for the four years here shown, which were treated in identical manner, show that there is, at least over this period, as constant an ability level as these measures are capable of measuring.

In the examination of the classmate data, it was noted that the boys were superior in test score, but that the girls were superior in achievement in high school, and that this was true for all three school types. A similar examination of the data on doctorate-holders is of interest, and is shown below in Table 8.

Table 8

High School Profiles of Men and Women Doctorate-Holders
By Type of School, and Sex Difference Scores on Six Variables

Sex	School Type	GPA 1 Language	GPA 2 Soc.St.	GPA 3 Math	GPA 4 Science	Normalized Rank	Test Score
F	Public	70.0	68.7	66.7	67.6	70.7	66.5
	Denominational	70.8	69.5	68.6	68.8	68.6	66.2
	Independent	67.2	66.3	65.5	67.2	66.4	67.7
M	Public	64.5	65.5	64.2	65.7	66.1	64.6
	Denominational	65.6	65.7	64.5	65.6	66.6	64.9
	Independent	61.8	62.3	62.4	63.8	64.2	66.8
F-M	Public	5.5	3.2	2.5	1.9	4.6	1.9
	Denominational	5.2	3.8	4.1	3.2	2.0	1.3
	Independent	5.4	4.0	3.1	3.4	2.2	.9

The familiar pattern of maximum difference in favor of the women in languages again appears, but it is particularly noteworthy that the women PhD's are superior not only in achievement, but also in measured aptitude. This confirms the finding of the earlier study of 1958 doctorate-holders, in which it was found that the women PhD's were brighter, by any index that was used, than men in the same fields of specialization. Another way of looking at the data in the above table is to consider the differences between the doctorate-holders and their classmates, holding sex and school type constant. This is done in Table 9 below.

Table 9

Differences between Doctorate-Holders and Their Classmates, On Six Variables, by Sex and Type of High School

Sex	School Type	GPA 1 Languages	GPA 2 Soc.St.	GPA 3 Math	GPA 4 Science	Normalized Rank	Test Score
F	Public	11.6	12.1	9.9	10.7	13.1	11.7
	Denominational	12.8	12.6	12.4	12.4	13.3	11.9
	Independent	8.7	9.0	9.0	9.0	10.7	9.5
M	Public	11.2	10.9	9.6	10.6	11.9	9.0
	Denominational	10.7	9.4	9.9	11.4	11.7	7.1
	Independent	7.9	7.1	7.2	9.0	8.9	5.1

In Table 9, where boys are compared with boys, and girls with girls, any generalized sex difference is cancelled out, leaving only that which may be attributed to secondary factors associated with the fact that relatively few women go on to the doctorate, and are accordingly more highly selected on ability than are the men. On each variable, for each school type, the difference between the doctorate-holders and classmates is greater for the women than for the men, and it does not change very much from one variable to another, within school type. The variations by school type are informative, also. For women, the greatest differences are in the denominational category; for men, in the public school category, and for both sexes, the smallest differential is in the independent schools. This would strongly indicate that the independent schools, which have the highest average ability level, send more of their graduates on to the doctorate--quite as would be expected on the basis of the socio-economic status of their parents.

When the superiority of women over men doctorate-holders was noted in the study of the 1958 graduates, the hypothesis was advanced that this was due primarily to the greater hurdles that the women had to overcome to attain the doctorate degree. As a consequence of "higher hurdles" it was hypothesized that only the more able made it. If this hypothesis is correct, then it might well follow that if still greater hurdles were put in the way, still higher ability levels would be found for the successful graduates. This can be tested in the present case by comparing the ability levels of those women who were married at the time they attained the doctorate with those who were single. It is assumed, in doing this, that marriage and its attendant responsibilities is a handicap rather than a help in further academic attainment for the women. Table 10 and Figures 1 and 2 provide the data relevant to this question for all fields in which the number of women was sufficient for reliable statistics. In math, physics, geo-sciences, and engineering the trend was the same, but the small numbers of women make the detailed data unreliable. The illustrations in Figures 1 and 2 were selected to show both natural and social sciences; as Table 10 shows, similar trends are evident in all the fields.

The hypothesis with regard to relative abilities of the men and women, and with respect to married vs. single women gains strong support from the data of Table 10. The data with respect to the men, however, raises another question: why the superiority of the single men as compared with the married? A number of hypotheses (the most interesting ones merely facetious) immediately suggest themselves. In any event, the "hurdles" hypothesis advanced with respect to the women does not seem to be very useful here. More probably a satisfactory explanation is to be found by considering the variables which correlate positively with marital status and negatively with ability. One of these is age. It seems quite reasonable to expect that those who are slowest in completion of doctoral requirements are, on the average, less able scholastically than those who complete the requirements earlier; being older, they are much more likely to be married by the time the degree is earned. In the study of the high school backgrounds of the 1958 doctorate-holders, the ability level of the older men in each field was found to be lower than that of the younger men, as is generally found in any age-grade comparison. A full exploration of the reasons for the ability differential between married and single men is beyond the feasible scope of the present report; it is expected that further study will provide a definitive test of the hypothesis here advanced.

Table 10

High School Ability Profiles, by Field, for Men and Women PhD's By Marital Status at Time of Doctorate

Field	Sex	Mar. Stat.	GPA 1	GPA 2	GPA 3	GPA 4	Normalized Rank	Test Score
All Fields Combined	F	marr	70.3	68.8	67.4	68.4	71.0	68.3
		sgl	69.8	68.7	66.7	67.3	69.7	65.4
		tot	70.0	68.7	66.9	67.8	70.2	66.6
	M	marr	63.9	64.9	63.7	65.2	68.4	64.5
		sgl	66.9	67.4	65.9	67.7	65.5	65.8
		tot	64.4	65.4	64.0	65.6	66.1	64.7
Chemistry	F	marr	71.1	70.6	72.2	72.2	72.9	69.9
		sgl	71.4	71.0	72.0	71.4	72.0	68.0
	M	marr	65.6	66.7	67.0	69.0	67.8	65.2
		sgl	67.2	68.1	67.7	69.8	69.6	66.2
Bio-Sciences	F	marr	71.3	70.1	69.9	71.4	72.7	69.6
		sgl	70.5	70.0	68.3	70.0	70.8	66.4
	M	marr	62.5	63.8	62.6	64.9	63.8	62.0
		sgl	65.0	66.0	64.1	67.3	66.1	63.2
Psychology	F	marr	70.2	68.6	67.0	67.6	70.1	69.3
		sgl	70.2	67.8	66.1	67.2	69.9	66.6
	M	marr	61.8	62.9	60.5	62.3	62.8	64.7
		sgl	64.0	64.5	62.1	63.8	64.8	65.2
Social Sciences	F	marr	72.5	71.5	68.0	70.0	71.8	68.0
		sgl	70.4	69.4	66.6	68.6	69.3	66.7
	M	marr	64.3	66.2	62.4	63.9	65.5	64.8
		sgl	67.3	68.2	63.9	66.0	67.6	65.2
Arts and Professions	F	marr	72.1	69.9	67.9	69.3	72.2	68.3
		sgl	71.6	70.0	67.8	67.6	71.7	66.8
	M	marr	65.2	65.4	62.7	64.1	65.6	65.4
		sgl	68.6	68.2	65.0	66.5	69.3	66.4
Education	F	marr	66.5	65.1	63.5	64.1	66.9	64.4
		sgl	67.7	66.8	64.4	65.1	66.8	61.5
	M	marr	60.9	62.2	60.0	61.1	61.7	60.3
		sgl	64.1	64.3	61.4	62.9	63.5	59.2

Figure 1

Profile of Bio-Scientists, by Sex and Marital Status At Doctorate, on Six High School Variables

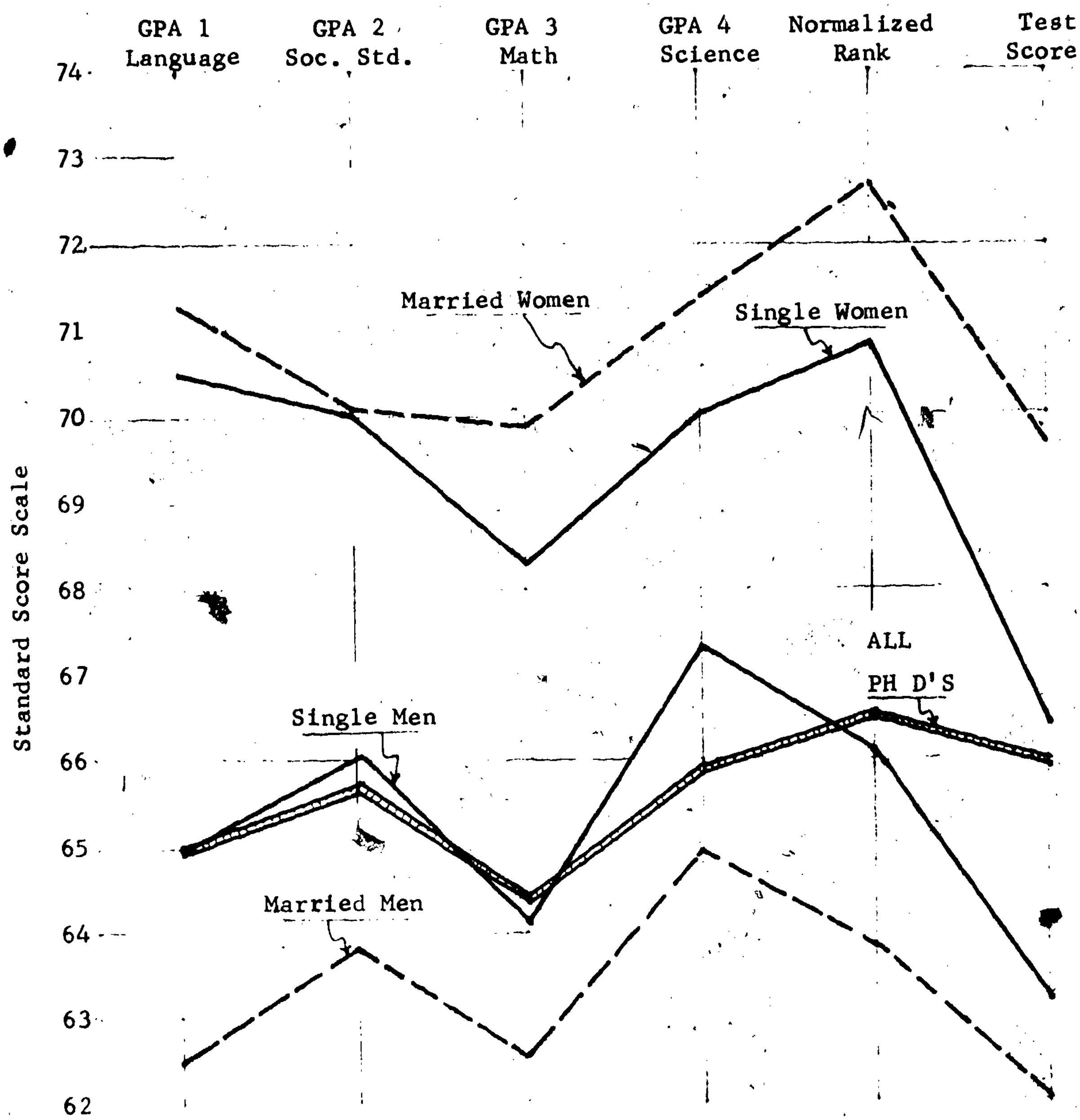
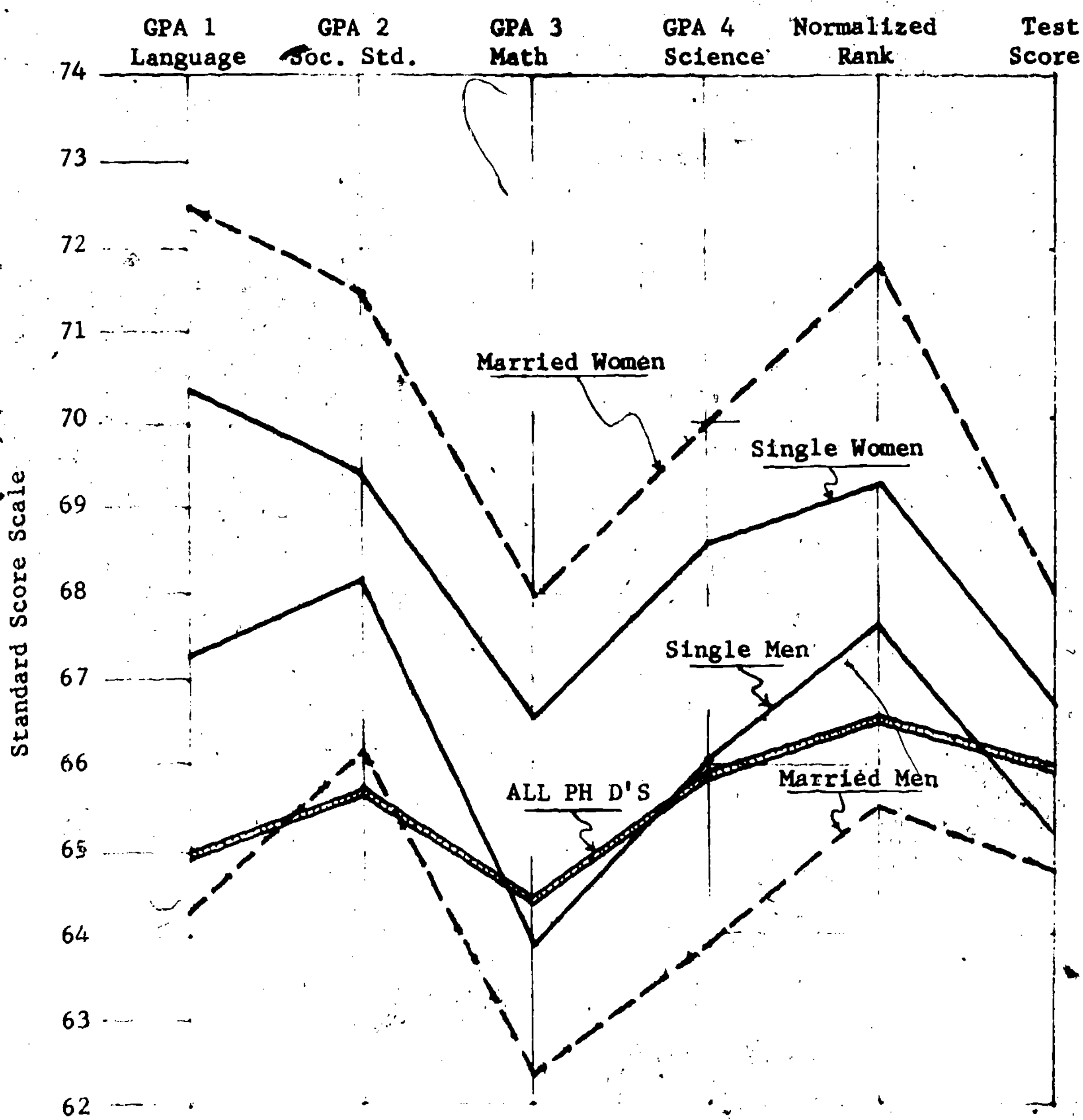


Figure 2

Profile of Social Scientists, by Sex and Marital Status At Doctorate, on Six High School Variables



...schools large and small

Size of graduating class has been found to be related to doctorate productivity. The ability level of the PhD graduates of these schools is, accordingly, of considerable interest. If the "hurdles" hypothesis evoked with respect to the women doctorates is to apply here, one would expect that the graduates of the small schools (at least the small public schools) who eventually attain doctorates would be more able than those of the larger schools with more favorable conditions. For the purpose of evaluating this hypothesis, only normalized rank and test score variables appear to be pertinent, and these need to be compared with those of the classmates from schools of the same size and type, to control any artifacts which may apply to both the doctorate-holders and others alike. Table 11 gives the data on the doctorate-holders by size and type of school. Table 12 gives the doctorate-classmate differences for these two variables, also by size and type of school.

Table 11

Normalized Rank and Test Score Means on Doctorate-Holders
By School Type and Size of Graduating Class

Size of Graduating Class	Normalized Rank: Public	Normalized Rank: Denom.	Normalized Rank: Indep.	Normalized Rank: All Types	Test Score: Public	Test Score: Denom.	Test Score: Indep.	Test Score: All Types
1-19	64.6	65.1	62.9	64.5	63.6	67.2	66.5	64.6
20-39	66.1	64.6	64.1	65.6	64.0	65.0	66.5	64.6
40-59	66.3	65.8	63.6	65.9	63.4	63.7	67.1	64.0
60-99	66.7	67.5	65.5	66.7	64.5	65.9	65.3	64.8
100-199	66.5	67.6	65.5	66.6	64.4	65.4	68.6	64.7
200-499	66.9	69.8	63.4	67.9	65.2	64.1	68.3	65.2
500 & up	66.3	67.5	66.8	66.3	65.2	63.8	68.5	65.2
Total, all sizes	66.5	66.9	64.4	66.5	64.8	65.1	66.9	64.9

Table 12

PhD-Classmate Differences in Normalized Rank and Test Score By School Type and Size of Graduating Class

Size of Graduating Class	Normalized Rank: Public	Denom.	Indep.	All Types	Test Score: Public	Denom.	Indep.	All Types
1-19	11.1	10.1	10.4	10.9	9.4	9.7	9.0	9.3
20-39	10.3	10.0	10.2	10.3	10.0	8.8	6.5	8.9
40-59	11.5	10.6	7.7	10.9	10.6	6.8	6.7	9.3
60-99	11.3	13.1	9.6	11.4	10.0	9.8	5.9	9.5
100-199	10.5	12.9	7.5	10.6	8.6	7.7	4.4	8.7
200-499	10.9	13.6	10.1	11.9	9.6	6.6	3.5	9.3
500 & up	9.9	12.1	15.7	9.9	9.9	8.2	7.5	8.9
Total, all sizes	10.7	11.9	9.1	10.8	9.6	8.1	5.7	9.1

Very little data of either of the above tables shows any consistent trends, with two possible exceptions: the PhD-classmate difference for the independent schools seems to be negatively related to size of graduating class, and there seems to be a mild negative correlation between test score and class size for the public school column. It must be remembered, in interpreting Tables 11 and 12, that the data for the larger class sizes are unreliable for the private schools, both church-related and independent, because the numbers of cases in these categories are small. In summary, no support is found here for the "hurdles" hypothesis, insofar as the supposed handicap of small class size is concerned.

...private-parochial-public hierarchy maintained

It is worth noting that, with respect to measured ability, the independent schools rank first in five out of seven class sizes, and the public schools rank third in five out of seven sizes, the exceptions being the largest class sizes, where data for the private schools are unreliable, and where selectivity of the public schools is most frequently encountered.

...above and beyond tested ability

Another comparison in Tables 11 and 12 is perhaps more significant than those concerned with the "hurdles" hypothesis. The doctorate-holders are higher on normalized rank than on test score in 23 of the 28 possible comparisons by size and type of school. The exceptions are in the smaller of the private schools of both categories. When the PhD-classmate differences are examined, the normalized rank scores show the greatest difference in all but one cell, where there is no difference. For the total of all schools in Table 12, the PhD-classmate difference is 10.8 points in normalized rank and 9.1 points in test score. A small portion of this difference (4%) could be accounted for on the basis of the larger standard deviation of the normalized rank scores (9.7) as compared with that of the test scores (9.3). Allowing for this difference in distributions, the PhD-classmate difference in normalized score is still larger than the test score difference by 14%--not a large amount, but enough to suggest further examination. For the public schools, the ratio of the two differences (normalized rank/test score) is only 1.06; for the denominational schools, it is 1.41, and for the independent schools it is 1.53. Earlier data have indicated--in line with prior expectations--that the grading standards of the private schools, and particularly the independent ones, are more rigorous than those of the public schools, perhaps largely in consequence of their selective admissions policies, as compared with the "comprehensive" role of most of the public high schools. Within the private school group, the PhD graduates are more outstanding relative to their classmates on normalized rank than they are on test score, whereas in the public schools the difference is minimal. Whether this same pattern would hold with respect to highly-selective public schools is an interesting question, but one which could not be pursued within the time and budget limitations of the present investigation.

This pattern of differences of rank vs. test score might be interpreted to indicate that the eventual doctorate-holders are not only brighter, but, for a given level of native ability, are more studious than their non-PhD classmates. In view of the importance of grade-getting all through the educational system, up to and including graduate school, this would seem to be a reasonable interpretation. Rank in high school class is generally found to be at least as good a predictor of college success as is test score, in spite of the wide variations found in school quality and academic standards. Whether it would be as good a predictor of non-academic criteria is of course quite another question--and one which might well be worthy of investigation if suitable non-academic criteria could be developed.

...so the Yankees win again

Regional differences in doctorate productivity (the proportion of high school graduates eventually achieving doctorates) have been found to be considerable. These differences in productivity are correlated with variations in ability level as measured by standard tests, as shown in Table 13, below. This table gives ability levels not only of the doctorate-holders, but also of their classmates, and includes the average PhD-classmate difference for normalized rank and for test score.

Table 13

Regional Variations in Normalized Rank and Test Score For Doctorate-Holders and Classmates

	Normalized Rank			Test Score		
Region	Doctorate-Holders	Class-mates	PhD-Clsmt. Difference	Doctorate-Holders	Class-mates	PhD-Clsmt. Difference
New England	66.1	55.6	10.5	65.3	56.6	8.7
Middle Atlantic	64.4	55.8	10.6	66.1	56.8	9.3
East North Central	66.7	55.7	11.0	64.8	55.5	9.3
West North Central	65.9	55.3	10.6	63.8	54.6	9.2
South Atlantic	66.5	55.6	10.9	64.4	55.3	9.1
East South Central	66.5	55.9	10.6	62.6	52.7	9.9
West South Central	66.3	55.7	10.6	64.2	55.5	8.7
Mountain	65.6	56.1	9.5	63.5	55.5	8.0
Pacific	67.6	56.2	11.4	64.0	54.9	9.1
U.S. Total	66.5	55.7	10.8	64.9	55.8	9.1

In Table 13, the inter-regional variations in normalized rank are not large, as these scores are based on local norms. The variations in tested ability are considerable, however, on both doctorate and classmate data, and are so highly correlated (rank-order correlation is .80) that the PhD classmate difference shows small variation from region to region. The same correlation on the normalized rank data is .62, while the inter-regional correlation between normalized rank and test score, for the doctorate-holders, is only .15. For individuals the correlation would of course be much higher. One regional anomaly that may be other than mere random-sampling variation is the low PhD-classmate difference in the mountain states, on both normalized rank and test score. An explanatory hypothesis, which would have to be checked by reference to other data, is that these data very largely reflect the influence of Utah, where the Mormon culture has encouraged a very high proportion of the students to go on to advanced education, thus reducing the difference between the doctorate-holders and high school graduates in general.

The distribution of school types is not uniform across the United States; private schools tend to be concentrated in the northeastern section. For this reason, a further table was produced, by type of school and geographic region, but limiting the geographic break-out to three areas: New England, the Middle Atlantic states, and all others. The basic data are given in Table 14, and abbreviated "profiles" are shown in Figure 3. The GPA scores have been left off these profiles, as they are substantially reflected in the normalized rank score.

Table 14

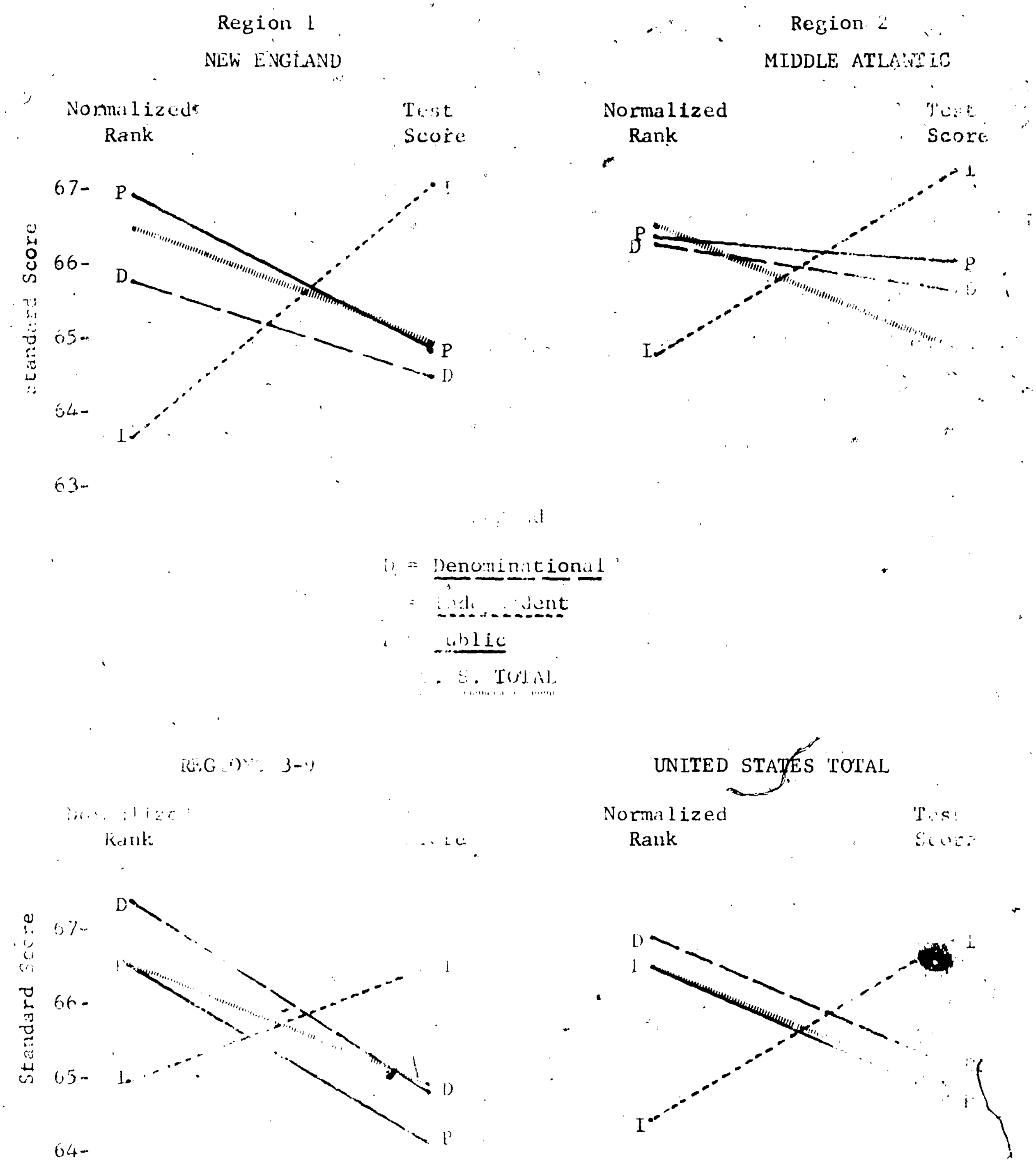
Ability Profiles by High School Type in Three Regions

Region	Type	GPA 1 Lang.	GPA 2 Soc.St.	GPA 3 Math	GPA 4 Science	Normalize Rank	-st Score
New England	Public	64.4	66.0	64.2	65.7	67.0	64.8
	Denominational	64.4	64.8	64.1	64.6	65.8	64.5
	Independent	59.3	60.2	60.5	62.0	63.7	67.1
Middle Atlantic	Public	63.0	64.4	63.3	64.6	66.4	66.1
	Denominational	64.3	64.5	63.0	64.7	66.3	65.7
	Independent	62.5	62.5	62.3	64.5	64.8	67.3
All Other Regions	Public	65.9	66.3	64.9	66.4	66.5	64.1
	Denominational	68.0	67.5	66.5	67.2	67.4	64.8
	Independent	65.2	65.5	65.2	66.2	65.0	66.5
U.S. TOTAL	Public	65.0	65.7	64.4	65.8	66.5	64.8
	Denominational	66.5	66.3	65.2	66.2	66.9	65.1
	Independent	62.4	62.9	62.7	64.3	64.4	66.9

The data for all doctorate-holders, for all types of schools and all regions combined, are shown in Figure 3 as a reference line against which the other patterns may be compared. In New England, for example, the public schools are slightly above this reference line in normalized rank, and slightly below it in test score, while the denominational schools are below on both variables. Exactly the reverse is true in the combined total of Regions 3 through 9, while in the Middle Atlantic states all three school types are below the reference line on normalized rank and above it on test score. The outstanding feature of Figure 3, of course, is the

Figure 3

Abbreviated "Profiles" by Type of School, in Three Regions



performance of the independent schools, which in all regions, but especially in New England, go counter to the trend of all the other schools. The relatively low score on normalized rank is undoubtedly a reflection of the fact that a high proportion of the graduates of these schools go on to the doctorate, thus lowering the percentile rank of the doctorate-attaining group.

...the two cultures

Field differences in normalized rank, math-science GPA, and test score were noted in the report on the 1958 doctorate-holders. The more extensive data of the present study, and its more accurate calibration, permit these factors to be examined in greater and more useful detail. The basic data for a general view of the results are given in Table 15, which has means for all six of the high school variables for each of ten doctorate fields. The same data are presented graphically in Figures 4 and 5. Figure 4 shows profiles of the natural science fields; Figure 5 shows profiles of the social sciences, arts, and professions. In each of the figures, the general average profile of all PhD fields combined is also included as a reference line. This is particularly important because the standard score scale ranges on the two graphs are not the same: in Figure 4 the scale runs from 63 to 71; in Figure 5 it runs from 60 to 68.

Table 15

High School Achievement and Aptitude Measures
For Ten Fields of Doctorate Specialization

Field	GPA 1 Languages	GPA 2 Soc.St.	GPA 3 Math	GPA 4 Science	Normalized Rank	Test Score
Mathematics	67.7	67.5	70.5	69.6	69.9	69.4
Physics	67.8	68.0	70.2	70.9	70.6	69.2
Chemistry	66.2	67.2	67.5	69.4	68.4	65.6
Geo-Sciences	63.8	64.9	63.9	66.0	65.6	64.7
Engineering	66.6	67.2	69.2	69.8	69.5	66.9
Bio-Sciences	63.6	64.7	63.4	65.7	64.9	62.7
Psychology	63.5	64.1	61.6	63.3	64.3	65.4
Social Sciences	65.4	66.9	63.0	64.7	66.3	65.1
Arts & Professions	66.8	66.7	63.9	65.2	67.2	65.9
Education	62.3	63.1	60.9	61.9	62.7	60.5

Figure 4

High School Profiles of Science Doctorates

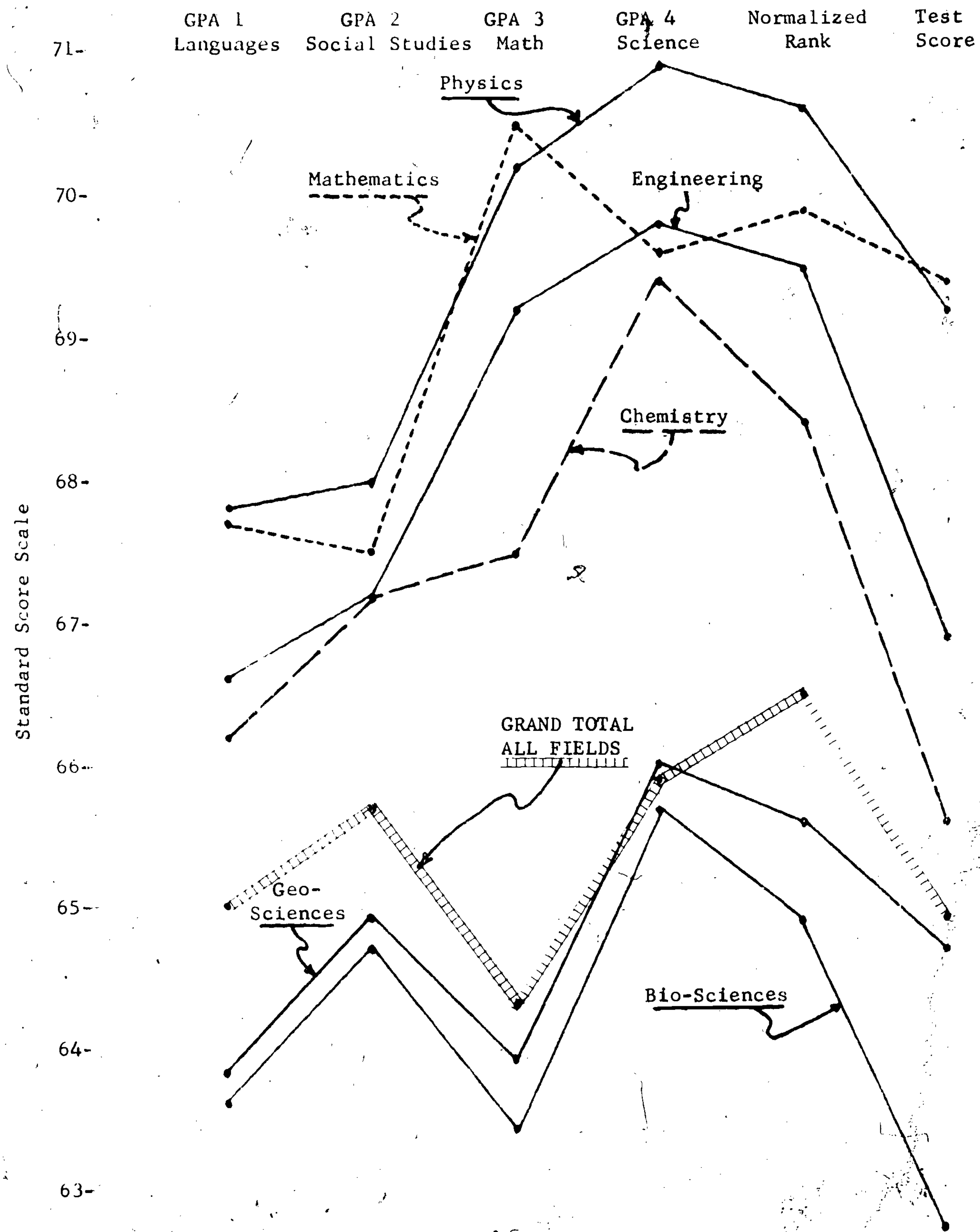
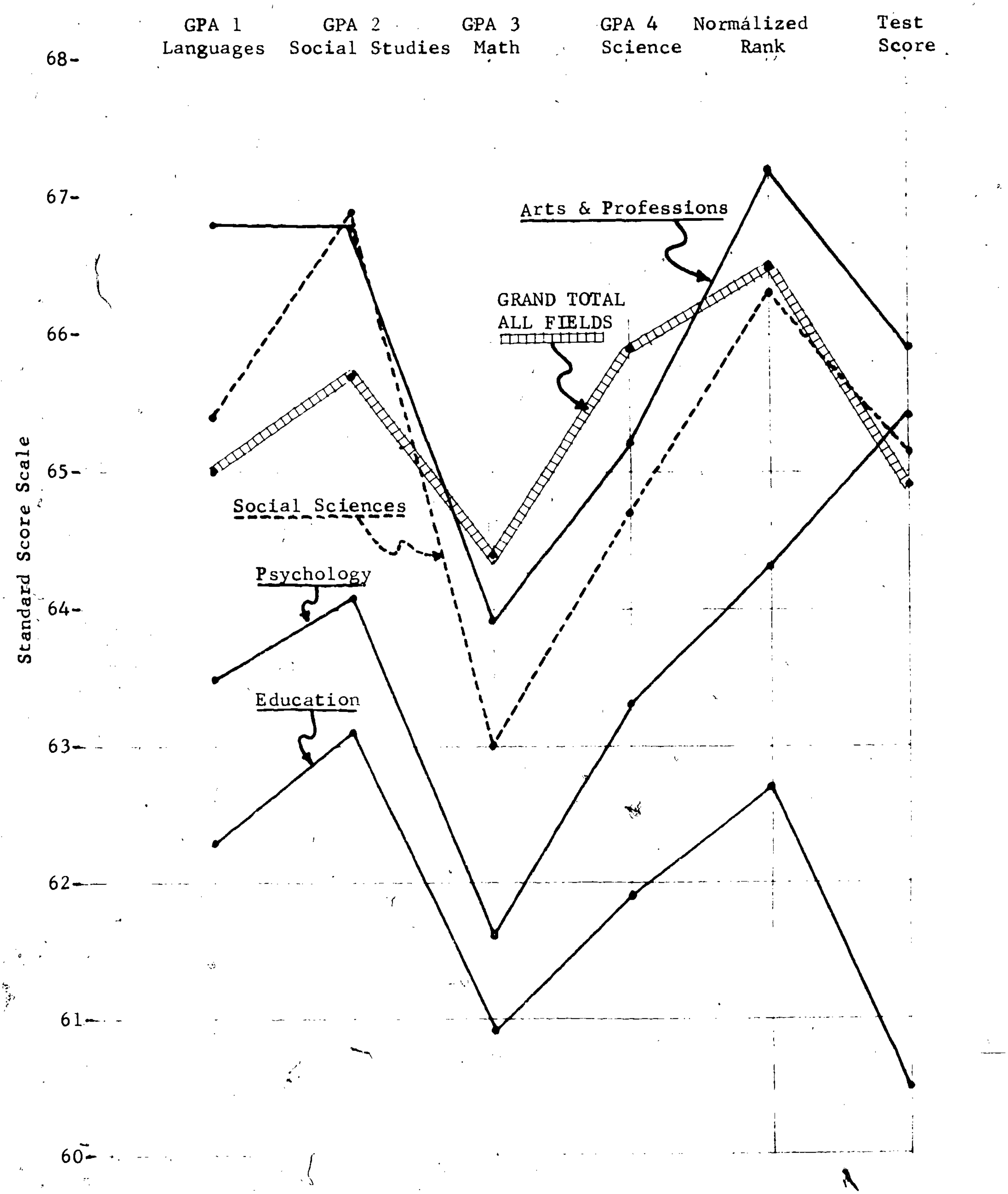


Figure 5

High School Profiles of Doctorates in Social Sciences, Arts, & Professions



...the general hierarchy

The two sets of profiles deserve careful study, as both the form of each profile and its general elevation provide significant information. The general level is the feature that first strikes the eye. The "hard sciences" of physics and chemistry, together with mathematics and engineering, are a distinct group at the top of Figure 4, well above the generalized profile of all fields combined. Geo-sciences and bio-sciences range in general below the generalized all-field profile. In Figure 5, the "arts and professions" group is above the general profile except in math and science GPA's; the social sciences profile criss-crosses the generalized profile, while psychology and education are well below except for the test score variable for psychology. Beyond these first observations regarding general elevation of the profiles, details of form are particularly important.

...profile form is important

The two top fields in Figure 4, mathematics and physics, are closely related disciplines, and yet the characteristic differences in the fields at the doctorate level are reflected in the profiles derived from high school data. The students who eventually became mathematicians did slightly better in mathematics in high school; the eventual physicists did distinctly better in the laboratory sciences in high school, and were somewhat better over-all achievers, although on tested aptitude there was a slight advantage for the eventual mathematicians. This pattern of differences, it might be recalled, was also noted on the 1958 doctorate-holders. The third profile of this physical science group is that for engineering, which closely parallels that for the physicists, but is in general about one standard score point lower on the achievement variables, and two points lower on tested scholastic aptitude. The chemistry profile is again nearly parallel and a bit lower except that chemists and engineers are tied on social studies GPA and the engineers are about two points higher on mathematics. In all four of these profiles, the mathematics GPA is above the language and social studies GPA; in this characteristic they are distinctly different from all the other doctorate fields. It may be well to note too at this point that the math profile is the only one of the ten fields in which the mathematics GPA is higher than the science GPA, and the only science field in which science GPA is lower than the normalized rank score. It is the only science profile in which language GPA exceeds social studies GPA. One might hazard the generalization that the mathematics profile indicates a much greater relative strength in the areas dealing with <u>form</u> than in the areas dealing with substantive <u>content</u>.

...earth and life sciences

The geo-science and bio-science profiles parallel rather closely the general profile of all fields combined, except for a relative strength in science GPA, and the relatively poor showing of the bio-science group on measured aptitude. In connection with the latter it should be noted that this group comes in large part from the rural areas, where depressed scores on standardized tests are quite characteristic; this might well be interpreted in this light rather than in terms of a vast difference in native ability. In both of these fields, in contrast to the four at the top of the figure, the mathematics GPA is distinctly below the social studies GPA and on a par with the language GPA. The relative weakness in the quantitative area may well have been important for a large number of these people in choosing fields in which substantial success could be attained without rigorous mathematical treatment of data.

...and the humanities

The "arts and professions" profile in Figure 5 is parallel to and above the generalized all-field profile except for the math and science GPA's, which are markedly depressed. The high contrast between this profile and the profiles of the physical scientists vividly calls to mind C. P. Snow's description of the "two cultures". If there is a communications gap between these two cultures, there is evidence here that it begins as far back as high school, and probably earlier. The contrast is even greater with respect to the social sciences group, which, in this tabulation, includes history (sometimes classified with humanities rather than social sciences). The social science and arts profiles are in general parallel except for the specific areas in which differences are to be expected--the notably greater verbal achievement of the humanities group and greater social studies achievement of those who eventually attain doctorates in social sciences. The final two profiles are those of psychology and education--quite parallel in the four GPA fields, diverging somewhat more in normalized rank, and substantially different in test score. With respect to the latter, it may be recalled that the psychologists come in large part from the big city schools; the educators in much greater proportion from small-town and rural sources.

...but the fields are not homogeneous

In the foregoing discussion of profiles, each field has been taken as a whole, without regard to the fact that wide variations exist within the fields. Some are relatively homogeneous; others, such as bio-sciences, encompass a very wide diversity of component fields, each distinct from at least some of the others. For a closer look at the within-field structure, further break-outs were attempted.

...200+ fine fields → 40+ subfield groups

The first step in examining intra-field profiles was to assemble the data for each of the subfields that is coded in the Doctorate Survey. In all, there are more than 200 such fine fields recognized, many of them with too few cases to permit reliable statistics in the present study. It was therefore necessary to re-assemble these fine fields into sub-field groups large enough so that the resulting profiles would have small random error. In this re-assembly, one point is important to observe: the field-grouping decisions must be made without regard to the profile statistics (other than numbers of cases). It would be easy to assemble fields which would show striking profile variations by grouping together those small fields which happen to have similar profile characteristics. This would capitalize on random-sampling variations, however, and one would have to expect, on a replication of the study, that most of these striking profiles would vanish like the shapes one sees in passing clouds. The re-combinations were therefore made on characteristics other than the immediate data, with a view to maintaining as great a degree of field homogeneity as possible while still assembling large enough numbers of cases for stable statistical results. In some cases, individual fields (as coded in the Doctorate Survey) were sufficiently large. In most cases groupings had to be made, and some of the decisions were necessarily arbitrary, throwing together into a single group sub-fields which the people engaged in these fields might feel to be strained. In most instances, however, the groups seem to be self-explanatory.

The data with regard to the various sub-fields, for the six high school variables, are shown in Table 16. Because there was not sufficient room on the table itself to spell out the various sub-fields included in each grouping, the groups are simply designated A, B, C, etc. Listed below are the sub-fields included in each of these letter-groups. The profile of each of these letter-groups was plotted, and the profiles visually examined. It was found that, with a few exceptions which will be discussed later, there was very little variation in form from one of the sub-fields to another, within the general groups shown in Figures 4 and 5. The graphs of the sub-fields are therefore omitted. The sub-fields did vary to a significant degree, however, in general height of profile. The arrangement of the sub-fields in Table 16 is generally in the order of the height of these profiles, with major emphasis put on the test score variable. This arrangement was not uniformly followed, however. Within the general bio-sciences group there are two sub-groups, agricultural and medical sciences, which are listed in that order because in the Doctorate Survey they comprise recognized categories which are not further described here.

Table 16

Ability Profiles on Six High School Variables for PhD Sub-Fields

Field & Sub-Field		GPA 1 Languages	GPA 2 Soc. St.	GPA 3 Math	GPA 4 Science	Normalized Rank	Test Score
Chemistry	A	67.5	68.5	68.4	70.2	69.5	66.9
	B	66.4	67.2	67.6	69.6	68.5	65.6
	C	64.1	65.7	65.1	66.3	65.8	63.4
Earth Sciences	A	64.1	64.2	64.0	65.8	65.6	66.0
	B	64.3	66.2	65.1	67.6	66.7	64.5
	C	63.2	64.3	62.6	64.8	64.9	63.8
Bio-Sciences	A	62.3	63.9	63.3	64.6	62.9	60.2
	B	63.9	65.7	64.0	66.1	65.2	64.2
	C	65.9	66.7	66.1	68.2	67.7	64.6
	D	63.5	64.4	62.8	65.6	65.1	62.6
	E	65.0	66.0	65.4	66.9	66.7	65.5
	F	63.6	64.4	62.7	65.5	64.3	62.2
	G	62.5	63.3	61.4	64.7	63.5	62.3
	H	63.2	64.3	62.1	64.8	64.0	62.0
Psychology	A	63.6	64.5	62.6	64.3	64.6	66.3
	B	64.1	64.2	62.7	63.7	65.3	66.5
	C	63.0	63.7	60.8	62.8	63.7	64.9
	D	63.5	63.7	61.1	62.9	63.7	63.3
Social Sciences	A	64.9	66.6	64.7	65.4	66.3	65.2
	B	66.2	67.8	64.2	64.8	66.6	65.4
	C	65.7	67.4	62.9	64.5	66.4	65.1
	D	64.8	65.6	62.4	64.3	65.7	63.8
	E	64.8	65.6	62.1	64.0	65.6	64.5
Arts and Prof's.	A	68.3	67.4	64.0	65.5	68.3	67.4
	B	67.7	67.5	66.1	67.2	68.0	67.5
	C	66.1	66.9	64.8	65.6	66.8	65.0
	D	64.7	64.6	61.7	63.2	65.2	63.0
Education	A	64.4	64.3	64.2	66.3	65.9	61.9
	B	63.5	64.0	61.0	62.8	62.7	59.9
	C	62.4	63.3	61.1	62.2	63.2	60.5
	D	62.8	63.6	60.9	62.1	63.0	62.0
	E	61.6	62.8	60.1	61.2	61.6	60.0
	F	61.9	62.[illegible]	60.9	62.1	61.8	60.2
	G	60.1	60.[illegible]	59.2	59.8	60.9	58.1

The various fields, with the sub-field groupings shown in Table 16, are given below with the fine fields included within each group. There are no listings for mathematics, physics, and engineering, because it was found that their sub-field profiles did not vary to a statistically significant degree. Some of the other fields show sub-field profiles which are only marginal in significance. However, wherever even marginally-significant data appeared, they were included for such value as they might have.

Chemistry	A analytical, nuclear, theoretical B organic, inorganic, physical C agricultural, pharmaceutical, other and general
Earth Sciences	A mineralogy, petrology, geo-chemistry B geo-physics, hydrology, geomorphology, meteorology, oceanography, structural geology, applied, other and general C stratigraphy, sedimentation, paleontology
Bio-Sciences	A agricultural and related B medical sciences C biochemistry D physiology, pharmacology, pathology E biophysics, biometrics, ecology, genetics, other and general F botany and phytopathology G zoology and entomology H hydrobiology and microbiology
Psychology	A comparative, physiological, experimental B industrial, personnel, personality, psychometrics, social, other and general C clinical D counseling, developmental, educational, school
Social Sciences	A economics, econometrics, statistics B history C geography, political science and public administration, international relations, other and general D sociology E anthropology, archeology, social work
Arts and Professions	A English, foreign languages, linguistics B philosophy, other and general C professional fields (business administration, home economics, law, journalism, library science, religion and theology) D arts (fine and applied art, music, speech and drama)
Education	A science education B elementary education C secondary education D foundations, educational psychology, measurement E administration and supervision F guidance, counseling, speech education, audio-visual aids G physical education

...physical sciences

A few comments on sub-fields within each of the ten general fields may be in order. As mentioned earlier, the sub-field profiles within math, physics, and engineering were essentially interchangeable. In chemistry, the sub-field profiles are distinguished only in general elevation, being very similar in form. In the geo-sciences, it is doubtful that the profile variations have much significance, but they are presented for examination. These fields are rather heterogeneous and the numbers of cases are not large. The profiles of the A and B groups cross in a way that is typical of a rural-urban difference, but it was not feasible to explore this possibility within the limits of the present study.

...form vs. function?

Within the broad bio-science category, the agricultural sciences group had in general the lowest profile, except in math and social studies GPA's. The biochemists were the highest on the achievement variables, but were exceeded on aptitude by the very heterogeneous group D, which includes more interdisciplinary elements than any of the others. This may give a clue as to the type of person who tends to go into the small, heterogeneous or emerging fields. One way in which the fields of biology can be grouped is of interest, as it shows a general separation of level but no great variation in form of profile: those fields which are concerned with basic processes and which involve the most quantitative treatment of data are generally higher all across the board (and particularly on math GPA) than are those with a major morphological orientation.

...social scientists

Within psychology, although four groups are presented, there are only two profiles that are distinct. Groups A and B have very similar profiles, as do groups C and D, the latter being separated mainly on measured ability. Although direct evidence is lacking in the present study, the latter difference is believed to parallel an urbanization distinction, the clinical psychologists tending to come disproportionately from the largest metropolitan centers. Among the other social sciences, the profiles run generally parallel, with little crossing except for the economics-statistics group, which excels, within the social sciences, on math and science, as might be expected. Groups D and E are quite indistinguishable in high school ability profiles, and are presented separately chiefly because there were sufficient sociologists to have a stable profile as a single group.

...arts and professions

Within the broad arts-humanities-professions group, the profiles are distinguished mainly by wide vertical separations, being little different in form except for a few anomalies in the case of the languages-linguistics group. This group is highest, as expected, on the language GPA, and also exceeds slightly the "philosophy, other, and general" group on normalized rank. The latter is unexpected in view of the very poor showing of this group on math and science GPA. To earn a higher over-all class rank, they must have taken only a bare minimum of courses in math and science, and concentrated in areas in which they earned the best grades. Within this verbalistic group, the foreign language majors generally do somewhat better than the English majors, but the profiles are very similar.

..."and I taught science and P. E...."

Education is the last major group. With the exception of the science and elementary education groups, the profiles are very similar in shape, and are distinguished only in general elevation--in which respect variations are substantial. The science education group is outstanding among the educators in science and math GPA, approximating the doctorate population as a whole in these two areas and also in normalized rank. The elementary education specialists lead the rest of the field (except science education) on all four GPA's, but drop below other groups on normalized rank and test score. The normalized rank being essentially a composite of the other four fields, this requires some explanation. It seems most probable that it is an artifact of the statistical procedure, as this group may well come disproportionately from small schools, perhaps rural, as suggested by the drop in test score. A statistical artifact is produced in normalized rank in the case of very small classes; within a class of ten, for example, the top student, however brilliant, can earn a percentile rank of only 95; in a class of five, a percentile rank of 90 would be the maximum possible. The second student in a class of ten would have a percentile rank of 85; the second of five a percentile rank of 70. These four percentiles would convert, respectively, to standard scores of 66, 63, 60, 55--illustrating the effect where very small classes are concerned.

To summarize the discussion of field profiles, it may be said that there are significant differences in both form and elevation for the various general doctorate fields; the major separation on both form and elevation is in the area of math and science achievement. The physical science fields are outstanding, as expected, in math and science GPA's; they are also outstanding in general profile elevation. Those fields which have the highest general profiles are also the most homogeneous; the sub-field groupings attempted in this study showed no significant differences within the doctorate fields of mathematics, physics, and engineering. Within the other fields, separations in general level were frequently observed, but only occasionally were the shapes of the profiles significantly different within a major field category. There were hints as to the possible significance of choice of subject, and avoidance of subjects in which students felt they would do poorly. All of these factors will be examined in a somewhat different manner in the following chapter, which will attempt to show in a quantitative fashion the degree of separation that is possible, taking all the high school data together in a manner which optimally weights each element to permit a distinction between those who later specialize in various doctorate disciplines.

CHAPTER VI MULTIVARIATE ANALYSIS

The objective of the multivariate analysis conducted in this study was to state in an objective and quantitative form the degree to which people who obtained degrees in the several doctorate fields could be distinguished from one another on the basis of high school data alone. Each item of available information from the high school is correlated with the eventual choice of doctorate field and with all other items of information. On the basis of this matrix of inter-correlations, those items which discriminate are sorted out and optimally weighted to maximize the discrimination. Several different methods are then available to express this discrimination in objective, quantitative fashion. This chapter will describe the choice of cases for analysis, provide a simplified (perhaps over-simplified) description of technique, summarize the results of this analysis, and compare these results with those obtained on the 1958 cases.

...by field and sex

The first decision was to analyze separately the men and the women. This provides a more rigorous test of technique and of the influence of high school data alone, as can be seen by the fact that separation on sex alone would tend to sort out the doctorate-holders by general field. There are very few women physicists, engineers, or geologists, relatively few chemists or mathematicians, and considerably more women in the other fields. The next decision was to attempt two levels of separation: the five general fields, using both men and women, but separately, and then the five fields of the physical sciences, using men only. These stages will permit maximum comparison with the field pattern data described in Chapter V.

...stratified-random selection

One of the requirements of the multivariate analysis program employed here was that complete data be available on each case. This restriction eliminated a substantial proportion of the cases which have been included in all the preceding analyses. All of those that remained could have been used within the field and sex categories described in the preceding paragraph. But it was deemed cumbersome and unnecessary to use them all. Rather, a selection technique was used to provide smaller but representative samples. For the five general fields, the male sample had 200 men in each field: the physical sciences, bio-sciences, social sciences, arts and professions, and education. Within each of these fields, selection was made on a stratified basis, to give the sub-fields representation in proportion to their occurrence in the general doctorate population. Within sub-fields, selection was by a random process. Essentially the same procedure was used with the women doctorate-holders, but there were not enough of them to provide 200 for each field, so the analysis proceeded with the following numbers for each of the five fields, respectively: 39, 101, 159, 144, 132. In the male sample within the physical sciences, the numbers were as follows: math 42, physics 74, chemistry 200, geo-sciences 33, engineering 116. These are in approximately the right proportions for the years covered in the present analysis.

...random deviations on ability measures

As must be expected when a smaller sample is drawn from a parent population, the ability profiles of the analysis samples were not exactly the same as for the total group. The deviations were within the bounds expected on a random sampling basis, however, and show the same characteristic patterns found on the total group and described in Chapter V. Table 17, below, gives the standard score means of each sample on the six achievement and aptitude variables for which comparisons are available. Other measures used in the analysis, but for which comparative data are not available, are here omitted as essentially meaningless. although useful in the discriminant analysis.

Table 17

Means on Six Variables, for Three Multivariate Analysis Samples

Sex and Field		GPA 1 Languages	GPA 2 Soc. St.	GPA 3 Math	GPA 4 Science	Normalized Rank	Test Score
Men	Physical Sciences	66.4	66.9	68.2	69.7	69.0	66.0
	Bio-Sciences	61.8	63.3	60.9	64.3	63.4	61.2
	Social Sciences	64.0	65.9	61.4	63.3	64.7	65.0
	Arts & Prof's.	66.1	65.6	62.9	63.9	66.4	65.8
	Education	60.7	61.9	58.4	61.0	61.4	59.5
Women	Physical Sciences	71.6	70.2	71.1	71.2	73.4	68.7
	Bio-Sciences	71.1	70.4	69.0	71.2	71.9	68.0
	Social Sciences	71.0	69.2	67.4	68.8	70.5	67.7
	Arts & Prof's.	72.4	70.5	68.0	68.4	72.6	67.5
	Education	67.7	66.8	62.9	63.3	66.9	61.5
Men	Mathematics	69.0	69.1	71.0	70.6	71.1	69.1
	Physics	67.5	66.7	70.7	70.7	69.6	68.3
	Chemistry	65.6	66.0	66.2	68.2	68.0	64.4
	Geo-Sciences	63.4	66.1	61.9	64.1	64.5	64.8
	Engineering	66.5	67.6	68.5	69.7	69.1	65.1

...options exercized indicate interest

In addition to these standard six ability measures, counts were made of the number of courses available but not taken in each of the four areas represented by GPA's in the foregoing table. There is some uncertainty regarding the availability of courses in some of the cases; the schools were asked to state whether courses listed on the form, but not taken by the student, were available at the time the student was in school. In some cases this information was provided by the school; in some instances it could be deduced from the records of other students at that school for approximately the same time period; in some instances the information on availability was missing. To the extent that the data are reliable, however, it is felt that they represent a measure of the direction of the student's interest, and hence should be useful as a supplement to the ability measures. In addition to these measures relating to the student, three high school measures were available, having to do with size of graduating class, public vs. private control, and, within the private sector, church-related or not. It was these 13 measures or categories that formed the basis for the field discriminations described below.

...a swarm of bees in discriminant space

To picture the results of a multivariate analysis, let us start by visualizing a hive of bees "swarming". They are in flight, centered around the queen bee, but dispersed out from this center in a wide envelope, denser at the center and sparser toward the outer edges, with some strays far from the main swarm. The queen bee in this analogy we will call the "group centroid". The whole swarm is analogous to the PhD's in one field of specialization. Now visualize four other similar swarms all in the air at the same time and partly intermixed with each other and the first swarm, but each tending to cluster around its own queen. The five queens would be the five field-group centroids. Although such a simultaneous swarming is a most unlikely event in nature, the analogy may serve us well here. Suppose that we were now to classify the bees according to their nearness to a given queen, whether their own or not. This would give us the analogy to the classification of individuals accoring to their high school data. We could then compare the results for the whole set of 1000 bees--or PhD's. Each can now be designated by his own actual field and by the field to which he is assigned on the basis of an optimally-weighted combination of scores from the high school data.

...latitude, longitude, altitude

The statistical procedures of the multivariate analysis first describe the "discriminant space" in which the five hives of bees are swarming. In our analogy, these would be a north-south dimension and an east-west dimension, like the familiar map coordinates, and altitude. As it turns out, the swarms are not separated much in altitude--none get very far from the ground. They are spread out more in a north-south direction than they are east-and-west; about two thirds of the discrimination can be obtained by use of the north-south separation alone, about one fourth by separating on longitude, and less than 10% by altitude separation. Figure 6 provides a two-dimensional map, with the group centroids (the queen bees) located appropriately. There are two sets in this case, one for the male PhD's in the five general fields, one for the females. On the map it will be noted that there are different latitude markings for the males and the females, but one scale suffices for differentiation of longitude. The spread of the swarms of bees (PhD's) about each of these group centroids will have to be imagined from the further data describing the ability of the multivariate system to sort them out. A great deal of overlapping occurs, as will be seen.

...for the statistically sophisticated

In the description in this report we will limit ourselves to the non-technical analogy, recognizing that to the statistically sophisticated this may be a somewhat unsatisfactory account. For a description of the multivariate techniques involved, the reader is referred to Multivariate Procedures for The Behavioral Sciences by William W. Cooley and Paul R. Lohnes (Wiley, 1962). For the statistical data of the present study, other than the classification matrices, which will be presented shortly, see Appendix F. We will introduce only one term here, which will be found useful later: the trace. This is an index of the over-all discrimination between groups that is achieved by the statistical analysis. The square root of the trace is approximately equal in significance to the multiple correlation in the more familiar regression analysis. It will be used in this chapter in this way to link these results with those achieved in other studies by correlational methods.

...latitude, a math-science dimension

The first dimension derived from the analysis of the 13 variables and their relationship to the five general fields is a math-science dimension, as might be expected from examination of the field profiles in Chapter V. This dimension involves ability, as shown by the GPA's, but includes also the tendency to take math and science courses when they are available, and to avoid optional social studies courses (too little challenge?). Persons high on this dimension are relatively non-verbal, obtaining higher marks in math and science subjects than in English and foreign languages. (It would not follow that their English grades were poor.) This dimension is rather unrelated to intelligence test measures, which are chiefly verbal. It is a dimension which tends to distinguish the people who eventually choose one of the "hard sciences" rather than some other field of specialization. It accounts for about two thirds of the discrimination among the five general fields--more than twice as much as does the second dimension.

...longitude, a verbal dimension

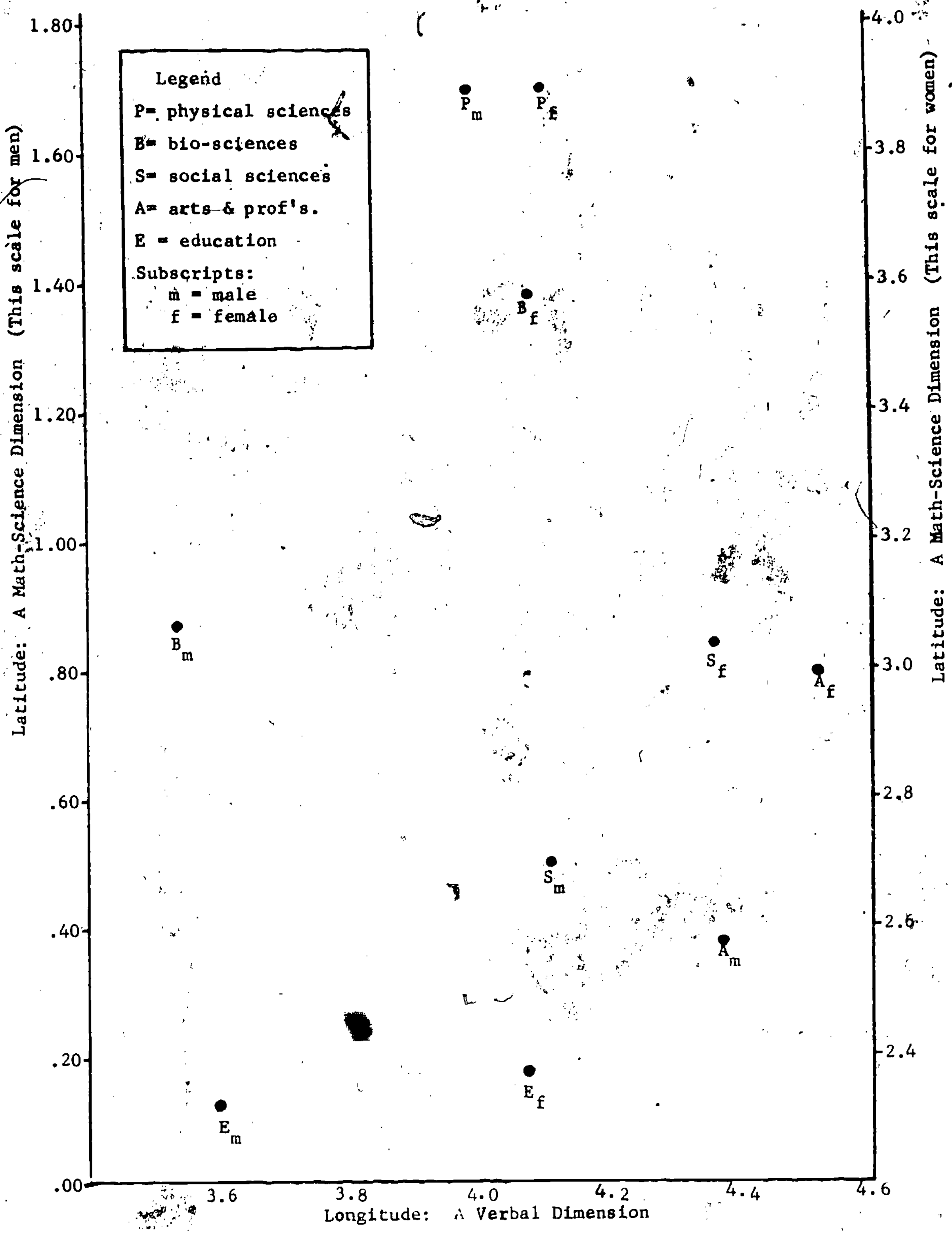
The second dimension is a verbal one, and accounts for about one fourth of the discriminant space. People scoring high on this dimension do well on the intelligence tests, in English and foreign languages, and achieve relatively high standing in their graduating class, do relatively poorly in their science courses, and avoid science where possible, concentrating on the more verbal subjects. Interestingly enough, they do not avoid the math courses. There is some tendency for persons high on this dimension to come from private rather than public schools, particularly from the independent rather than the church-related ones. They tend to eventually earn doctorates in the arts and humanities, are rare in the bio-science and education fields.

...altitude, an uncertain dimension

The third dimension is much less distinct in meaning. Its strongest characteristics are that the people high on this dimension are low in science GPA, and tend to avoid science courses. This dimension is negatively related to test score but positively related to normalized rank, positively to school size, and is likely to be more characteristic of people in the arts and education fields, less characteristic of psychologists and social scientists. This is a weak dimension, in addition to being somewhat indistinct in meaning. It

Figure 6

A Statistical Map Locating Five Field-Group Centroids in a Two-Dimensional Discriminant Space, Scaled in Latitude for Separate Analyses for Men and for Women



accounts for only about 7% to 8% of the discrimination among the five general fields. There is also a very weak fourth dimension, which should not be taken seriously, as it accounts for less than 3% of the discrimination found. Four dimensions (n-1) are the maximum possible in a situation with only five groups to be distinguished; this fourth dimension probably has more "noise" than "signal" in its make-up, and will not be further discussed.

...and now to sort the bees

We may turn now from the description of the dimensions of the discriminant space to our bee-swarm analogy and the problem of sorting the bees according to any of various systems. The objective is to assign as many bees as possible to their proper swarms solely by use of the data of their latitude, longitude, and altitude in relation to the group centroids, and our knowledge of how the various swarms are dispersed around the centroids. Having made the classifications by whatever system we choose, we then, in effect, ask each bee what swarm he really belongs to, and compare our assignments with the actuality. The percentage of correct assignments we will call the "hit rate". As a point of reference in evaluating this hit rate, we can recall that, with five equal groups, as in the five general fields with male doctorate-holders, we would achieve a 20% hit rate by a random process alone. In the cases of the groups of unequal size, the random-hit percentages would vary according to the relative frequencies of the several groups.

...two geometric taxonomies

Actually, there are several ways of assigning bees to a given classification swarm, or PhD's to a given "classification field". One could depend solely on the distance of each individual bee from the five queens, or group centroids. This introduces a matter of metrics. We have three dimensions, but we can modify the metric by introducing the concept of group dispersion, and measure the distance in "centours". This term is a combination of percentile and contour, the latter adapted from the contour lines of a topographic map. If one is dealing in three-dimensional space, as here, the contour lines about the queen bees become a series of envelopes. The "elevation" between the envelopes we would measure in terms of the percentage of the swarm of bees, and hence term these contour-envelopes centours. Each bee can be located in terms of the percentage of bees farther from the queen than he is. This can be done for all five queens, giving him five centour scores. We could then simply classify him in terms of the group in which he has the highest centour score. This is essentially the technique of Method I, the results of which are shown in the ensuing tables. Or we could get more sophisticated and take into consideration the relative size of the five swarms and the closeness or looseness of the dispersion of the individuals about each centroid. This is the technique of Method II. As will be seen, the results are somewhat different, depending on the circumstances of the individual analysis. Other techniques also could be developed, but these will suffice for the purposes of the present report.

Table 18

Multiple Discriminant Classification of Male PhD's in Five General Fields, On the Basis of High School Data, Using Two Different Methods

Method I							Method II				
Field of Classification							Field of Classification				
Phy. Sci.	Bio-Sci.	Soc. Sci.	Arts, Prof.	Educ.	Actual Doctorate Field	N	Phy. Sci.	Bio-Sci.	Soc. Sci.	Arts, Prof.	Educ.
118	26	21	23	12	Phy. Sci.	200	145	24	13	13	5
46	52	31	20	51	Bio-Sci.	200	63	63	23	16	35
32	20	58	45	45	Soc.Sci.	200	48	37	54	35	26
32	10	42	85	31	Arts,Prof.	200	48	18	36	73	25
13	24	24	41	98	Educ.	200	20	44	22	35	79
241	132	176	214	237	Total	1000	324	186	148	172	170

Hit Rate = 41.1% (Method I)

Hit Rate = 41.4% (Method II)

The cases underlined in Table 18 are those which lie along the diagonal, and include those where the field of classification and actual doctorate field are the same. These are the "hits" and their total number divided by the number of cases in the whole table, gives the hit rate. In Table 18, although the men are differently assigned by the two methods, the over-all hit rate is essentially the same for the two methods. As another way of describing the amount of discrimination, one may consider the square root of the "trace". It precedes and is not dependent upon the method of classification. In the case of the 1000 male PhD's in five general fields, $\sqrt{\text{trace}} = .72$. As mentioned earlier, this can be considered the numerical equivalent, for this sort of problem, of the multiple correlation coefficient.

Table 19

Multiple Discriminant Classification of Women PhD's in Five General Fields, On the Basis of High School Data, Using Two Different Methods

Method I					Actual		Method II				
Field of Classification							Field of Classification				
Phy. Sci.	Bio-Sci.	Soc. Sci.	Arts, Prof.	Educ.	Doctorate Field	N	Phy. Sci.	Bio-Sci.	Soc. Sci.	Arts, Prof.	Educ.
21	4	1	10	3	Phy.Sci.	39	2	20	6	8	3
45	20	15	10	11	Bio-Sci.	101	0	52	31	10	8
20	20	34	48	37	Soc. Sci.	159	0	29	70	35	25
26	11	11	64	32	Arts,Prof.	144	1	22	41	57	23
13	10	11	22	76	Educ.	132	0.	16	27	18	71
125	65	72	154	159	Total	575	[illegible]	139	175	128	130

Hit Rate = 37.4% (Method I)   Hit Rate = 43.8% (Method II)

In the case of the women, it will be recalled, there were only 575 cases, rather than 1000, and they were not distributed uniformly across all fields. The same general dimensions of discrimination were found, as shown in Figure 6, and the general level of discrimination was found to be very similar: the $\sqrt{}$trace was computed at .68, rather than .72, the over-all index for the men. The same two methods of classification were employed, but, as might be expected because the numbers of cases in the several fields were unequal, the results of the two methods are not quite the same. Method II, which takes into account the fact of unequal numbers and group dispersions, proves to be a bit superior, as shown in Table 19.

...for men only

The third analysis concerned the shred-out of the physical science field into its five component fields of mathematics, physics, chemistry, geo-sciences, and engineering. In this case, as might be expected because the group is more homogeneous, the discrimination is less effective. The $\sqrt{}$trace is only .60, a small but probably reliable difference which can be attributed to the fact that we are shooting at a somewhat smaller target. The classification matrices for the physical sciences group are shown in Table 20.

Table 20

Multiple Discriminant Classification of Men in Physical Sciences Into Sub-Fields on the Basis of High School Data

Method I: Field of Classification					Actual Doctorate		Method II: Field of Classification				
Math	Phys.	Chem.	Geo-S.	Engin.	Field	N	Math	Phys.	Chem.	Geo-S.	Engin.
10	15	4	3	10	Math	42	2	6	21	1	12
9	29	11	8	17	Physics	74	0	13	35	1	25
15	33	78	41	33	Chem.	200	0	11	160	6	23
2	2	3	19	7	Geo-S.	33	0	0	21	8	4
10	29	14	19	44	Engin.	116	2	5	60	4	45
46	108	110	90	111	Total	465	4	35	297	20	109

Hit Rate = 38.7%   Hit Rate = 49.0%

It may seem paradoxical that the highest hit rate is achieved in the case where the over-all discrimination is lowest. This is achieved, however, by Method II, which takes advantage of the extraordinary concentration in the field of chemistry. Actually, an arbitrary assignment of all cases to chemistry would achieve a hit rate of 200/465, or 43% in this particular instance. The hit rate is thus not an unambiguous method of evaluation of a classification system when the numbers of cases in the categories to be distinguished are widely different.

...a discriminant summary

The quantitative evaluation of the degree to which doctorate-holders can be separated into their eventual fields of specialization on the basis of high school data alone has been shown by several indices. We may consider the over-all index, $\sqrt{trace}$, as being the most convenient summary statistic. It ranges from .60 to .72, values which some statisticians equate with multiple correlation coefficients of the same magnitude. Or one may consider the "hit rate" when the cases are classified into five groups on the basis of the high school data alone. In general, the latter method gives about 40% correct classification--about twice as many as would be achieved by a purely random method where the five categories are equal in size. This is about the same as was found previously for the 1958 doctorate-holders. In that case, however, separate analyses by sex were not attempted. In the present case, additional data in the form of language and social studies GPA's were available. As a consequence, it may be said that the additional data has helped the discrimination but perhaps only marginally so.

CHAPTER VII CONCLUSIONS

- Despite the massive increase in doctorate production, there has been no measurable change in ability level of the PhD's. (p. 26)

- The doctorate-holders are, on the average, 1 1/2 standard deviations above the mean of the general population in measured ability. (p. 25)

- A random sample of the girls graduating in the same classes as the doctorate-holders scored slightly lower than their male counterparts on standardized tests, but achieved better grades, particularly in verbalistic subjects. (p. 17)

- Women doctorate-holders are superior to their male counterparts on all measures derived from high school records, in all fields of specialization. Those who were married at the time they achieved the doctorate are superior to their spinster colleagues. (pp. 27-32)

- Among the male PhD's, those who were single at the time of doctorate graduation were superior in high school to their colleagues who were married at the time they received the doctorate. This is probably because superior students complete the degree at a younger age, and hence have a lower marriage rate. (pp. 29-32)

- Regional differences in measured ability follow the same general pattern for doctorate-holders and their non-doctorate high school classmates. (p. 23) Highest test scores were found in the northeast, lowest in the south. (p. 36)

- Measured ability by school type shows the same hierarchy for doctorate-holders (p. 37) and their non-doctorate classmates (pp. 18-19): independent schools are highest, denominational schools intermediate, and public schools lowest, although regional variations are evident. (p. 38)

- Striking ability differences appear when the various doctorate fields are compared. (p. 39) The "hard sciences" are highest in all fields except language achievement, where they are exceeded only by arts-humanities majors. This field hierarchy is essentially the same as that shown by the earlier study of the doctorate recipients of 1958. Within the sciences, math and physics vie for first place, followed by engineering, chemistry, geology, and bio-sciences, in that order, when general level of the profile is considered. (p. 40)

- Outside the natural sciences, the humanities are highest, followed by the social sciences, psychology, and education, in general profile level. (p. 41)

- Pattern or shape of profile in high school achievement and aptitude also differentiates the fields, even such similar fields as mathematics and physics. Two general types appear: those high in math and science GPA, and those relatively low in these subjects (math, physics, chemistry and engineering are in the first group; all other fields in the second). (p. 40)

- Within these two general types, differences are usually where they would be expected: mathematicians have their highest score in math GPA; all natural science fields in science GPA; arts-humanities majors have their highest score in languages; social scientists in social studies--and psychologists in aptitude tests!

- Sub-fields within the ten general fields are sometimes clearly differentiated by general level of profile, seldom by shape of profile, although a few notable exceptions to this rule were found. (pp. 44-48)

- Multiple discriminant analysis permits the extraction of dimensions of the high school data by which about two out of five doctorate-holders can be correctly classified into their eventual field of doctorate, using high school data alone, in a situation where one out of five would be correctly classified by a random process. (pp. 50-59)

- A great deal of additional information of value for an understanding of the educational process was collected in the course of this study, but remains unexplored, awaiting further investigation.

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Appendix A

Doctorate-Holders in Analysis Sample, by Type of School, Region, and Size of Graduating Class

Total, All School Types

Region of High School		Total, All Sizes	1-9	10-19	20-39	40-59	60-99	100-199	200-499	500 & up
TOTAL, ALL	N	20440	233	970	2330	1860	2490	3995	6010	2552
REGIONS	%	100.0	1.1	4.7	11.4	9.1	12.2	19.5	29.[illegible]	12.5
New	N	1676	16	54	174	155	213	372	526	166
England	%	100.0	1.0	3.2	10.4	9.2	12.7	22.2	31.4	9.9
Middle	N	5426	25	122	366	320	559	1100	1768	1168
Atlantic	%	100.0	.5	2.2	6.7	5.9	10.3	20.3	32.6	21.5
East North	N	4279	27	181	441	371	503	863	1441	452
Central	%	100.0	.6	4.2	10.3	8.7	11.8	20.2	33.7	10.6
West North	N	2323	59	216	448	299	307	408	460	126
Central	%	100.0	2.5	9.3	19.3	12.9	13.2	17.6	19.8	5.4
South	N	1705	16	90	269	211	243	[illegible]5	443	88
Atlantic	%	100.0	.9	5.3	15.8	12.4	14.3	[illegible]2	26.0	5.2
East South	N	[illegible]	17	84	169	121	139	142	132	20
Central	%	100.0	2.1	10.2	20.5	14.7	16.9	17.2	16.0	2.4
West South	N	1378	33	116	251	171	198	240	272	97
Central	%	100.0	2.4	8.4	18.2	12.4	14.4	17.4	19.7	7.0
Mountain	N	882	16	56	101	83	131	161	202	132
	%	100.0	1.8	6.3	11.5	9.4	14.9	18.3	22.9	15.0
Pacific	N	[illegible]45	24	51	111	129	197	364	766	303
	%	100.0	1.2	2.6	5.7	6.6	10.1	18.7	39.4	15.6

Public Schools

Region of High School		Total, All Sizes	1-9	10-19	20-39	40-59	60-99	100-199	200-499	500 & up
TOTAL, ALL	N	17614	169	752	1684	1369	1983	3431	5710	2516
REGIONS	%	100.0	1.0	4.3	9.6	7.8	11.3	19.5	32.4	14.3
New	N	1163	11	26	73	74	106	262	448	163
England	%	100.0	.9	2.2	6.3	6.4	9.1	22.5	38.5	14.0
Middle	N	4592	1[illegible]	[illegible]1	189	166	392	939	1680	1145
Atlantic	%	100.0	.2	1.3	4.1	3.6	8.6	20.5	36.7	25.0
East North	N	372[illegible]	21	158	338	289	409	717	1349	446
Central	%	100.0	.6	4.2	9.1	7.8	11.0	19.2	36.2	12.0
West North	N	2068	[illegible]	190	370	248	274	363	447	125
Central	%	100.0	2.[illegible]	9.2	17.9	12.0	13.2	17.6	21.6	6.0
South	N	1478	12	61	203	160	203	312	439	88
Atlantic	%	100.0	.8	4.1	13.7	10.8	13.7	21.1	29.7	6.0
East South	N	717	11	65	134	107	119	133	128	20
Central	%	100.0	1.5	9.1	18.7	14.9	16.6	18.5	17.9	2.8
West South	N	1271	23	109	219	157	184	215	267	97
Central	%	100.0	1.8	8.6	17.2	12.4	14.5	16.9	21.0	7.6
Mountain	N	838	[illegible]	51	89	73	127	154	199	130
	%	100.0	[illegible]	6.1	10.6	8.7	15.2	18.4	23.7	15.5
Pacific	N	1770	15	31	69	95	168	336	753	302
	%	100.0	.8	1.8	3.9	5.4	9.5	19.0	42.5	17.1

Appendix A, Continued

Doctorate-Holders in Analysis Sample, by Type of School, Region, and Size of Graduating Class

Denominational Schools

Region of High School		Total, All Sizes	1-9	10-19	20-39	40-59	60-99	100-199	200-499	500 & up
TOTAL, ALL REGIONS	N	1861	40	130	399	314	318	409	223	28
	%	100.0	2.1	7.0	21.4	16.9	17.1	22.0	12.0	1.5
New England	N	175	2	11	35	31	40	33	22	1
	%	100.0	1.1	6.3	20.0	17.7	22.9	18.9	12.6	.6
Middle Atlantic	N	584	7	33	105	101	112	125	79	22
	%	100.0	1.2	5.7	18.0	17.3	19.2	21.4	13.5	3.8
East North Central	N	433	4	16	69	59	72	125	85	3
	%	100.0	.9	3.7	15.9	13.6	16.6	28.9	19.6	.7
West North Central	N	204	8	20	59	39	22	43	12	1
	%	100.0	3.9	9.8	28.9	19.1	10.8	21.1	5.9	.5
South Atlantic	N	147	1	16	48	31	24	25	[illegible]	
	%	100.0	.7	10.9	32.7	21.1	16.3	17.0	1.[illegible]	
East South Central	N	70	5	14	22	8	10	7	4	
	%	100.0	7.1	20.0	31.4	11.4	14.3	10.0	5.7	
West South Central	N	87	8	6	24	11	10	23	5	
	%	100.0	9.2	6.9	27.6	12.6	11.5	26.4	5.7	
Mountain	N	32		5	9	8	3	4	2	1
	%	100.0		15.6	28.1	25.0	9.4	12.5	6.3	3.1
Pacific	N	129	5	9	28	26	25	24	12	
	%	100.0	3.9	7.0	21.7	20.2	19.4	18.6	9.3	
Independent Schools										
TOTAL, ALL REGIONS	N	965	24	88	247	177	189	155	77	8
	%	100.0	2.5	9.1	25.6	18.3	19.6	16.1	8.0	.8
New England	N	338	3	17	66	50	67	77	56	2
	%	100.0	.9	5.0	19.5	14.8	19.8	22.8	16.6	.6
Middle Atlantic	N	262	8	28	72	53	55	36	9	1
	%	100.0	3.1	10.7	27.5	20.2	21.0	13.7	3.4	.4
East North Central	N	119	2	7	34	23	22	21	7	3
	%	100.0	1.7	5.9	28.6	19.3	18.5	17.6	5.9	2.5
West North Central	N	51		6	19	12	11	2	1	
	%	100.0		11.8	37.3	23.5	21.6	3.9	2.0	
South Atlantic	N	80	3	13	18	20	16	8	2	
	%	100.0	3.8	16.3	22.5	25.0	20.0	10.0	2.5	
East South Central	N	37	1	5	13	6	10	2		
	%	100.0	2.7	13.5	35.1	16.2	27.0	5.4		
West South Central	N	20	2	1	8	3	4	2		
	%	100.0	10.0	5.0	40.0	15.0	20.0	10.0		
Mountain	N	12	1		3	2	1	3	1	1
	%	100.0	8.3		25.0	16.7	8.3	25.0	8.3	8.3
Pacific	N	46	4	11	14	8	3	4	1	1
	%	100.0	8.7	23.9	30.4	17.4	6.5	8.7	2.2	2.2

Appendix B

Classmates by Decile, by Region: Final Analysis Sample

Region		All Ranks	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-100
			Percentile Rank									
TOTAL, ALL REGIONS	N	10831	1022	1038	1080	1101	1176	1166	1107	1081	1038	1022
	%	100.0	9.4	9.6	10.0	10.2	10.9	10.8	10.2	10.0	9.6	9.4
New England	N	1033	104	95	109	110	96	104	110	109	100	96
	%	100.0	10.1	9.2	10.6	10.6	9.3	10.1	10.6	10.6	9.7	9.3
Middle Atlantic	N	2995	266	300	298	312	320	323	312	298	300	266
	%	100.0	8.9	10.0	9.9	10.4	10.7	10.8	10.4	9.9	10.0	8.9
East North Central	N	2882	270	265	303	285	310	319	285	303	265	277
	%	100.0	9.4	9.2	10.5	9.9	10.8	11.1	9.9	10.5	9.2	9.6
West North Central	N	1290	144	112	121	146	146	134	136	121	112	118
	%	100.0	11.2	8.7	9.4	11.3	11.3	10.4	10.5	9.4	8.7	9.1
South Atlantic	N	785	86	77	68	70	97	86	70	68	77	86
	%	100.0	11.0	9.8	8.7	8.9	12.4	11.0	8.9	8.7	9.8	11.0
East South Central	N	235	19	33	21	21	21	28	21	25	23	23
	%	100.0	8.1	14.0	8.9	8.9	8.9	11.9	8.9	10.6	9.8	9.8
West South Central	N	556	46	54	60	54	65	53	62	57	55	50
	%	100.0	8.3	9.7	10.8	9.7	11.7	9.5	11.2	10.3	9.9	9.0
Mountain	N	382	25	47	26	43	42	47	43	35	40	34
	%	100.0	6.5	12.3	6.8	11.3	11.0	12.3	11.3	9.2	10.5	8.9
Pacific	N	673	62	55	74	60	79	72	68	65	66	72
	%	100.0	9.2	8.2	11.0	8.9	11.7	10.7	10.1	9.7	9.8	10.7

Appendix C

Grade Point Average Conversion Chart 1: Language and Social Studies

GPA 1: Languages Standard Score					
Original GPA	.0	.2	.4	.6	.8
89	76.2	76.3	76.4	76.6	76.7
88	75.6	75.7	75.8	75.9	76.1
87	75.0	75.1	75.2	75.3	75.5
86	74.3	74.5	74.6	74.7	74.8
85	73.7	73.9	74.0	74.1	74.2
84	73.1	73.2	73.4	73.5	73.6
83	72.5	72.6	72.7	72.9	73.0
82	71.9	72.0	72.1	72.3	72.4
81	71.3	71.4	71.5	71.6	71.8
80	70.7	70.8	70.9	71.0	71.1
79	70.0	70.2	70.3	70.4	70.5
78	69.4	69.5	69.7	69.8	69.9
77	68.8	68.9	69.1	69.2	69.3
76	68.2	68.3	68.4	68.6	68.7
75	67.6	67.7	67.8	68.0	68.1
74	67.0	67.1	67.2	67.3	67.5
73	66.4	66.5	66.6	66.7	66.8
72	65.7	65.9	66.0	66.1	66.2
71	65.1	65.2	65.4	65.5	65.6
70	64.5	64.6	64.8	64.9	65.0
69	63.9	64.0	64.1	64.3	64.4
68	63.3	63.4	63.5	63.6	63.8
67	62.7	62.8	62.9	63.0	63.2
66	62.0	62.2	62.3	62.4	62.5
65	61.4	61.6	61.7	61.8	61.9
64	60.8	60.9	61.1	61.2	61.3
63	60.2	60.3	60.4	60.6	60.7
62	59.6	59.7	59.8	60.0	60.1
61	59.0	59.1	59.2	59.3	59.5
60	58.4	58.5	58.6	58.7	58.8
59	57.7	57.9	58.0	58.1	58.2
58	57.1	57.2	57.4	57.5	57.6
57	56.5	56.6	56.8	56.9	57.0
56	55.9	56.0	56.1	56.3	56.4
55	55.3	55.4	55.5	55.6	55.8
54	54.7	54.8	54.9	55.0	55.2
53	54.1	54.2	54.3	54.4	54.5
52	53.4	53.6	53.7	53.8	53.9
51	52.8	52.9	[illegible]	53.2	53.3
50	52.2	52.3	52.5	52.6	52.7

GPA 2: Social Studies Standard Score					
Original GPA	.0	.2	.4	.6	.8
89	74.3	74.4	74.6	74.7	74.8
88	73.7	73.8	74.0	74.1	74.2
87	73.1	73.2	73.4	73.5	73.6
86	72.5	72.6	72.8	72.9	73.0
85	71.9	72.1	72.2	72.3	72.4
84	71.3	71.5	71.6	71.7	71.8
83	70.7	70.9	71.0	71.1	71.2
82	70.1	70.3	70.4	70.5	70.6
81	69.5	69.7	69.8	69.9	70.0
80	69.0	69.1	69.2	69.3	69.4
79	68.4	68.5	68.6	68.7	68.8
78	67.8	67.9	68.0	68.1	68.2
77	67.2	67.3	67.4	67.5	67.6
76	66.6	66.7	66.8	66.9	67.0
75	66.0	66.1	66.2	66.3	66.4
74	65.4	65.5	65.6	65.7	65.9
73	64.8	64.9	65.0	65.1	65.3
72	64.2	64.3	64.4	64.5	64.7
71	63.6	63.7	63.8	63.9	64.1
70	63.0	63.1	63.2	63.3	63.5
69	62.4	62.5	62.6	62.8	62.9
68	61.8	61.9	62.0	62.2	62.3
67	61.2	61.3	61.4	61.6	61.7
66	60.6	60.7	60.8	61.0	61.1
65	60.0	60.1	60.2	60.4	60.5
64	59.4	59.5	59.7	59.8	59.9
63	58.8	58.9	59.1	59.2	59.3
62	58.2	58.3	58.5	58.6	58.7
61	57.6	57.7	57.9	58.0	58.1
60	57.0	57.2	57.3	57.4	57.5
59	56.4	56.6	56.7	56.8	56.9
58	55.8	56.0	56.1	56.2	56.3
57	55.2	55.4	55.5	55.6	55.7
56	54.6	54.8	54.9	55.0	55.1
55	54.1	54.2	54.3	54.4	54.5
54	53.5	53.6	53.7	53.8	53.9
53	52.9	53.0	53.1	53.2	53.3
52	52.3	52.4	52.5	52.6	52.7
51	51.7	51.8	51.9	52.0	52.1
50	51.1	51.2	51.3	51.4	51.5

Grade Point Average Conversion Chart 2: Math and Science

	GPA 3: Math Standard Score						GPA 4: Science Standard Score				
Original GPA	.0	.2	.4	.6	.8	Original GPA	.0	.2	.4	.6	.8
89	74.1	74.2	74.4	74.5	74.6	89	74.8	74.9	75.0	75.1	75.2
88	73.6	73.7	73.8	73.9	74.0	88	[illegible]	[illegible]	74.4	74.5	74.6
87	73.1	73.2	73.3	73.4	73.5	87	[illegible]	[illegible]	73.8	74.0	74.1
86	72.5	72.6	72.7	72.8	73.0	86	73.0	[illegible]	73.3	73.4	73.5
85	72.0	72.1	72.2	72.3	72.4	85	72.5	72.6	72.7	72.8	[illegible]
84	71.4	71.6	71.7	71.8	71.9	84	71.9	72.0	72.1	72.2	72.4
83	70.9	71.0	71.1	71.2	71.3	83	71.3	71.4	71.6	71.7	71.8
82	70.4	70.5	70.6	70.7	70.8	82	70.8	70.9	71.0	71.1	71.2
81	69.8	69.9	70.0	70.2	70.3	81	70.2	70.3	70.4	70.5	70.6
80	69.3	69.4	69.5	69.6	69.7	80	69.6	69.7	69.8	70.0	70.1
79	68.8	68.9	69.0	69.1	69.2	79	69.0	69.2	69.3	69.4	69.5
78	68.2	68.3	68.4	68.5	68.6	78	68.5	68.6	68.7	68.8	68.9
77	67.7	67.8	67.9	68.0	68.1	77	67.9	68.0	68.1	68.2	68.4
76	67.1	67.2	67.4	67.5	67.6	76	67.3	67.4	67.6	67.7	67.8
75	66.6	66.7	66.8	66.9	67.0	75	66.8	66.9	67.0	67.1	67.2
74	66.1	66.2	66.3	66.4	66.5	74	66.2	66.3	66.4	66.5	66.6
73	65.5	65.6	65.7	65.8	65.9	73	65.6	65.7	65.8	66.0	66.1
72	65.0	65.1	65.2	65.3	65.4	72	65.1	65.2	65.3	65.4	65.5
71	64.4	64.5	64.7	64.8	64.9	71	64.5	64.6	64.7	64.8	64.9
70	63.9	64.0	64.1	64.2	64.3	70	63.9	64.0	64.1	64.3	64.4
69	63.4	63.5	63.6	63.7	63.8	69	63.3	63.5	63.6	63.7	63.8
68	62.8	62.9	63.0	63.1	63.3	68	62.8	62.9	63.0	63.1	63.2
67	62.3	62.4	62.5	62.6	62.7	67	62.2	62.3	62.4	62.5	62.7
66	61.7	61.9	62.0	62.1	62.2	66	61.6	61.7	61.9	62.0	62.1
65	61.2	61.3	61.4	61.5	61.6	65	61.1	61.2	61.3	61.4	61.5
64	60.7	60.8	60.9	61.0	61.1	64	60.5	60.6	60.7	60.8	60.9
63	60.1	60.2	60.3	60.5	60.6	63	59.9	60.0	60.1	60.3	60.4
62	59.6	59.7	59.8	59.9	60.0	62	59.3	59.5	59.6	59.7	59.8
61	59.0	59.2	59.3	59.4	59.5	61	58.8	58.9	59.0	59.1	59.2
60	58.5	58.6	58.7	58.8	58.9	60	58.2	58.3	58.4	58.5	58.7
59	58.0	58.1	58.2	58.3	58.4	59	57.6	57.7	57.9	58.0	58.1
58	57.4	57.5	57.6	57.8	57.9	58	57.1	57.2	57.3	57.4	57.5
57	56.9	57.0	57.1	57.2	57.3	57	56.5	56.6	56.7	56.8	56.9
56	56.4	56.5	56.6	56.7	56.8	56	55.9	56.0	56.1	56.3	56.4
55	55.8	55.9	56.0	56.1	56.2	55	55.3	55.5	55.6	55.7	55.8
54	55.3	55.4	55.5	55.6	55.7	54	54.8	54.9	55.0	55.1	55.2
53	54.7	54.8	55.0	55.1	55.2	53	54.2	54.3	54.4	54.5	54.7
52	54.2	54.3	54.4	54.5	54.6	52	53.6	53.7	53.9	54.0	54.1
51	53.7	53.8	53.9	54.0	54.1	51	53.1	53.2	53.3	53.4	53.5
50	53.1	53.2	53.3	53.4	53.6	50	52.5	52.6	52.7	52.8	52.9

Appendix D

NATIONAL ACADEMY OF SCIENCES
NATIONAL RESEARCH COUNCIL
2101 CONSTITUTION AVENUE, WASHINGTON 25, D. C.

OFFICE OF SCIENTIFIC PERSONNEL

To the Principal of the High School

Dear Sir:

In 1960 the National Academy of Sciences--National Research Council conducted a study of the high school backgrounds of the people who received third-level research degrees (not MD, DDS, or DVM) from United States universities in 1958. The response to our request for information at that time was almost universal, and was deeply appreciated. We are now undertaking a similar study of the doctorate graduates of 1959-1962, inclusive. You are to be congratulated on having four of your alumni in this group.

These doctorate-holders are named on the enclosed forms, which list their degrees and fields of specialization. We would like to secure, on a confidential basis, certain information about these graduates, from your high school records, for a research study now under way. We would also like to secure corresponding information regarding a classmate of each of these doctorate-holders, selected as indicated below.

The person whose record we wish to obtain on the reverse side of the doctorate-holder's form is to be the one ALPHABETICALLY NEXT AFTER the doctorate-holder. The only exception is where the doctorate-holder is himself the last person in the class, alphabetically. In this case, the person alphabetically next before him is to be chosen. These rules hold even where the person so chosen is himself one of the other doctorate-holders. In that case, this fact may be shown as indicated on the form.

In addition to the doctorate-holders for the 1959-62 period, our files include those who obtained doctorate degrees during 1957 and 1958; if there were any such graduates from your school, they are indicated on an enclosed roster. Because of our interest in the origins of these people, we should like to have information with respect to the community (the town, city or other political division) in which the school is located, and the school itself, as of the time when these people were in attendance. This information is requested in part on one side of the form, and in part on the other side, along with data for the classmate of the doctorate-holder.

You may be assured that any information you provide will be kept strictly confidental and will be used only for statistical analyses of groups of people and categories of schools. The enclosed reprints indicate some of the uses to which we put information provided by our previous study. We hope that these reports will be of interest to you.

Thanks for your cooperation.

Very truly yours,

Lindsey R. Harmon

Lindsey R. Harmon
Director of Research

Appendix D, Continued

National Academy of Sciences — National Research Council

OFFICE OF SCIENTIFIC PERSONNEL

Doctorate Data and High School Backgrounds Form

(SIDE ONE)

Dr. ______ was born in ______ in ______ graduated from ______ High School in ______ in ______ took a bachelor's degree in ______ in ______ at ______ and a doctorate in ______ at ______ in ______

serial number

Regarding this person, we should like to have the following information from his (or her) high school records, if available:

GRADES IN HIGH SCHOOL COURSES. Note all three points below ●

● Please check the letter grades earned by this person. If numerical grades were used, see numerical scales at the bottom of the page.* Otherwise ignore numerical scales.

● If more than one grade was given for any subject listed, check (✓) once for each grade awarded.

● If any course listed was not offered when this student was in school, check this first column indicating "Course Not Available"

	Course Not Available	A	B	C	D	F	COURSE NOT TAKEN	CODING DO NOT WRITE
ENGLISH COURSES								
Freshman								
Sophomore								
Junior								
Senior								
Other (specify)								
FOREIGN LANGUAGE COURSES								
French								
Spanish								
German								
Latin								
Other (specify)								
SOCIAL STUDIES COURSES								
United States History								
World History								
Geography								
Gov't (Problems of Democracy, Civics, etc.)								
Business (incl. Economics, Bus. Law, Accounting, etc.)								
Other (specify)								
MATHEMATICS COURSES								
Elementary Algebra								
Plane Geometry								
Solid Geometry								
Trigonometry								
Intermediate Algebra								
College Algebra								
Other (specify)								
SCIENCE COURSES								
General Science								
Biology								
Chemistry								
Physics								
Other (specify)								

ACADEMIC RANK (counting from the top of the class, e.g. 5th of 183)

This student was ______ (35-38) from the top of a class of ______ (39-42)

SCORES ON INTELLIGENCE TESTS (list most recent test first)

Name of test ______

Date of test ______ Score or IQ ______

Name of test ______

Date of test ______ Score or IQ ______

Name of test ______

Date of test ______ Score or IQ ______

What kind of elementary school did this student attend? (check) ____ public; ____ private, denominational; ____ private, non-denominational

The following questions (on both sides of this form) apply to the school and community, and hence to both the doctorate-holder and classmate (see other side)

QUESTIONS REGARDING THE SCHOOL AND THE COMMUNITY (town, city, or other political division) IN WHICH THE SCHOOL WAS LOCATED, WHEN THIS STUDENT GRADUATED

1. As of that time, the school could best be described as (check one)

____ College preparatory and general, offering a variety of courses for all students in its attendance area

____ Vocational, with specialized terminal education

____ Strictly college preparatory, with selective admissions requirements for college-bound students

____ Other (specify) ______

2. At that time the parents of the students at this school were (check the most descriptive category)

____ of above-average income for this community

____ of less than average income for this community

____ representative of the whole community

Were they a mixture of town and rural people from a wide geographic area? Yes ____ No ____

Coding Column Do Not Write in This Space: 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62

* NUMERICAL SCALES		A	B	C	D	F
	NATIONAL	91+	84-90	76-83	68-75	67 & below
	LOCAL					

Fill in the spaces to the left if only numeric scales were used at the time this student was in school.

PLEASE TURN THE PAGE AND COMPLETE THE QUESTIONS ON THE OTHER SIDE

* THIS scale is close to the national average practice in the 1940's, as judged from a previous survey

BUREAU OF THE BUDGET NO. 99-6309 APPROVAL EXPIRES 1 OCT 64

Appendix D, Continued

Doctorate Data and High School Backgrounds Form

Please supply to us the information requested below, regarding the student who was graduated ALPHABETICALLY FIRST AFTER THE DOCTORATE HOLDER named on the other side of this form, in the same graduating class. If this next person is himself in the doctorate group, check here and enter his serial number here ____

Name of Classmate:

Regarding this person, we should like to have the following information from his (or her) high school records, if available:

GRADES IN HIGH SCHOOL COURSES: Note all three points below ●

- Please check the letter grades earned by this person. If numerical grades were used, see numerical scales at the bottom of the page.* Otherwise ignore numerical scales.
- If more than one grade was given for any subject listed, check (✓) once for each grade awarded.
- If any course listed was not offered when this student was in school, check this first column indicating "Course Not Available"

	Course Not Available	A	B	C	D	F	COURSE NOT TAKEN	CODING DO NOT WRITE
ENGLISH COURSES								
Freshman								
Sophomore								
Junior								
Senior								
Other (specify)								
FOREIGN LANGUAGE COURSES								
French								
Spanish								
German								
Latin								
Other (specify)								
SOCIAL STUDIES COURSES								
United States History								
World History								
Geography								
Gov't (Problems of Democracy, etc.)								
Business (incl. Economics, Bus. Law, Accounting)								
Other (specify)								
MATHEMATICS COURSES								
Elementary Algebra								
Plane Geometry								
Solid Geometry								
Trigonometry								
Intermediate Algebra								
College Algebra								
Other (specify)								
SCIENCE COURSES								
General Science								
Biology								
Chemistry								
Physics								
Other (specify)								

* NUMERICAL SCALES						
NATIONAL	9[illegible]	84-90	76-83	68-75	below	
LOCAL						

[illegible] the spaces to the left if only numeric [grades] were used at the time this student [attended] school.

* This scale is close to the national average practice in the 1940's, as [shown] in previous surveys.

BUREAU OF THE BUDGET NO. 99-6307 APPROVAL EXPIRES 1 OCT 6[illegible]

ACADEMIC RANK (counting from the top of the class, e.g. 5th of 183)

This student was ____ (35-38) from the top of a class of ____ (39-42)

SCORES ON INTELLIGENCE TESTS (list most recent test first)

Name of test ____
Date of test ____ Score or IQ ____

Name of test ____
Date of test ____ Score or IQ ____

Name of test ____
Date of test ____ Score or IQ ____

What kind of elementary school did this student attend? (check) ____ public; ____ private, denominational; ____ private, non-denominational

SCHOOL AND COMMUNITY DATA, CONTINUED

The following questions, and those on the other side, apply to this school and community and hence to both the doctorate-holder and classmate.

3. How large was the population, at that time, of the community (town, city, or other political division) in which the school was located? (check one)

____ a. a half-million people or more
____ b. 100,000 to 499,999
____ c. 25,000 to 99,999
____ d. 5,000 to 24,999
____ e. 1,000 to 4,999
____ f. under 1000 people

Was it a suburb of a city of 100,000 people or more? Yes No

4. If this community was of less than 25,000 at the time these students were in attendance, how far was it to the nearest city of 25,000 or more? ____ 100,000 or more? ____ (enter distance in miles)

5. What percentage of the teachers in grades 9-12 at that time had advanced degrees (beyond BA or BS)?

enter percentage

6. What was the annual per pupil expenditure in this school at that time?

$ ____ (enter amount)

Do not write in the spaces below

1 2 3 4 5 6

Coding Column Do Not Write in This Space: 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62

PLEASE TURN THE PAGE AND COMPLETE THE QUESTIONS ON THE OTHER SIDE

Appendix D, Continued

22 0012 23

ROSTER OF GRADUATES WITH DOCTORATES 1957-1962

HS N J

1957-1958 DOCTORATES	YR OF GRAD	PHD INST.	FIELD	YEAR
''ENRY J	1935	COLUMBIA U.	ECONOMICS	1958
GIRAIR MIHRAN	1943	CAL TECH	CHEMISTRY	1957
IVAN GABRIEL	1947	COLUMBIA U	CHEMISTRY	1957

TOTAL 1957-1958 DOCTORATES - 3

1959-1962 DOCTORATES	YR OF GRAD	PHD INST.	FIELD	YEAR
JOHN HENRY	1930	NEW YORK U	EDUCATION	1962
HERBERT PAUL	1933	U COLORADO	EDUCATION	1960
ILLIAM WRIGHT	1938	COLUMBIA U	PHILOSOPHY	1959
ROCCO EUGENE	1938	U MARYLAND	EDUCATION	1960
ROBERT CHARLES	1938	TC - COL U	EDUCATION	1962
LLIAM HOWARD	1940	VANDERBILT	ECONOMICS	1961
ALICE FIELD	1942	NEW SCHOOL	PSYCHOLOGY	1959
ILLIAM HOWARD	1943	FLA ST U	EDUCATION	1961
GERALD	1943	JOHNS HOPK	FOREIGN LANG	1962
EE WILLIAM	1944	U MICHIGAN	ENGLISH	1961
ACK VINCENT	1946	RUTGERS U	EDUCATION	1960
ROBERT MORTON	1946	U WISC-MAD	OCEANOGRAPHY	1962
ONALD HENRY	1948	ADELPHI C	PSYCHOLOGY	1959
PHYLLIS A BENN	1948	COLUMBIA U	ANTHROPOLOGY	1962
HARRY	1948	TC - COL U	EDUCATION	1962
IETER RUDOLF	1950	PRINCETON	PHYSICS	1959
MARTIN LAWRENC	1951	POLY BKLYN	ENGINEERING	1961
IM PETER	1952	CAL TECH	BIOLOGY	1959
LIBERO MARX	1952	U VIRGINIA	HISTORY	1962
HENRY JOHN	1953	RUTGERS U	CHEMISTRY	1962

TOTAL 1959-1962 DOCTORATES - 20

TOTAL 1957-1962 DOCTORATES - 23

YOUR HIGH SCHOOL RANKS 13 IN YOUR STATE
AND IS TIED AT THAT RANK WITH 3 OTHER SCHOOLS
AND RANKS 313 IN THE UNITED STATES AND IS TIED
AT THAT RANK WITH 26 OTHER SCHOOLS.

(Note: Surnames in the above list have been obliterated to preserve privacy)

Appendix E

Standard Score Conversion Chart for Standard Test IQ's

SS	Henmon-Nelson Kuhlman-Anderson Cal.M.M.	Otis S.A.	Otis Quick-Scoring Beta, Gamma	Pressey Terman-McNemar [illegible] Army Alpha	[illegible]	ACE Percentile	Miller A	Standard Normal Curve Percentile Min	Max	SS
85	151	141-2	145-6	158-9	148		177-8	Min	Max	85
84	149-50	140	144	157	146-7		174-6			84
83	148	139	143	155-6	144-5		172-3			83
82	146-7	138	141-2	153-4	143	99.9	170-1			82
81	145	137	140	152	141-2	99.8	168-9			81
80	144	136	139	150-1	140	99.7	166-7	.9985		80
79	142-3	134-5	138	149	138-9	99.6	163-5	.9979	.9984	79
78	141	133	136-7	147-8	136-7	99.5	161-2	.9971	.9978	78
77	140	132	135	145-6	135	99.3	159-60	.9960	.9970	77
76	138-9	131	134	144	133-4	99.1	157-8	.9947	.9959	76
75	137	130	132-3	142-3	132	98.8	155-6	.9930	.9946	75
74	135-6	128-9	131	140-1	130-1	98.5	152-4	.9908	.9929	74
73	134	127	130	139	128-9	98.0	150-1	.9879	.9907	73
72	133	126	128-9	137-8	127	97.5	148-9	.9845	.9878	72
71	131-2	125	127	135-6	125-6	96.8	146-7	.9801	.9844	71
70	130	124	126	134	124	96.0	144-5	.9748	.9800	70
69	128-9	122-3	125	132-3	122-3	95.0	141-3	.9682	.9747	69
68	127	121	123-4	130-1	120-1	94.0	139-40	.9601	.9681	68
67	125-6	120	122	129	119	93.0	[illegible]7-8	.951[illegible]	.9600	67
66	124	119	121	127-8	117-8	91.0	135-6	.9401	.9510	66
65	123	118	119-20	125-6	116	90.0	133-4	.9271	.9400	65
64	121-2	116-7	118	124	114-5	88.0	130-2	.9121	.9270	64
63	120	115	117	122-3	112-3	85.0	128-9	.8953	.9120	63
62	119	114	115-6	120-1	110-11	83.0	126-7	.8761	.8952	62
61	117-8	113	114	118-9	109	80.0	124-5	.8543	.8760	61
60	116	112	113	117	108	77.0	122-3	.8301	.8542	60
59	114-5	110-11	112	116	106-7	74.0	119-21	.8048	.8300	59
58	113	109	110-11	114-5	104-5	71.0	117-8	.7748	.8047	58
57	112	108	109	112-3	103	68.0	115-6	.7438	.7747	57
56	110-11	107	108	111	101-2	64.0	[illegible]	[illegible]	.7437	56
55	109	106	106-7	109-10	100	60.0	[illegible]	[illegible]	.7210	55
54	107-8	104-5	105	107-8	98-9	56.0	[illegible]	[illegible]	.6758	54
53	106	103	104	106	96-7	52.0	[illegible]	[illegible]	.6385	53
52	105	102	102-3	104-5	95	48.0	104-5	.5616	.6015	52
51	103-4	101	101	102-3	93-4	44.0	102-3	.5201	.5615	51
50	102	100	100	101	92	40.0	100-1	.4801	.5200	50
49	100-1	98-9	99	99-100	90-1	36.0	[illegible]7-9	.4386	.4800	49
48	99	97	97-8	97-8	88-9	32.0	95-6	.3986	.4385	48
47	98	96	96	96	87	28.0	93-4	.3616	.3985	47
46	96-7	95	95	94-5	85-6	26.0	91-2	.3243	.3615	46
45	95	94	93-4	92-3	84	23.0	89-90	.2791	.3242	45
44	93-4	92-3	92	91	82-3	20.0	86-8	.2564	.2790	44
43	92	91	91	89-90	80-1	17.0	84-5	.2254	.2563	43
42	90-1	90	89-90	87-8	79	15.0	82-3	.1954	.2253	42
41	89	89	88	86	77-8	12.0	80-1	.1701	.1953	41
40	87-8	88	87	84-5	75-6	10.0	78-9	.1459	.1700	40
39	86	86-7	86	82-3	74	9.0	75-7	.1241	.1458	39
38	85	85	84-5	81	72-3	7.0	73-4	.1049	.1240	38
37	83-4	84	83	79-80	71	6.0	71-2	.0881	.1048	37
36	82	83	82	77-8	69-70	5.0	69-70	.0731	.0880	36
35	81	82	81	76	67-8	4.0	67-8	.0601	.0730	35
34	79-80	80-81	79-80	74-75	66	3.5	65-66	.0491	.0600	34
33	78	79	78	72-73	64-65	2.5	63-64	.0401	.0490	33
32	76-77	78	77	71	63	2.0	61-62	.0320	.0400	32
31	75	77	75-76	69-70	61-62	1.5	59-60	.0254	.0319	31
30	74	76	74	67-68	59-60	1.2	57-58	.0201	.0253	30
29	72-73	74-75	73	66	58	.9	55-56	.0157	.0200	29

Appendix F

Statistical Data of the Multiple Discriminant Analyses

Analysis 1: Five General Fields

Variable	Univariate F's				Scaled Vectors					
	Male		Female		Vector I		Vector II		Vector III	
	F	p	F	p	M	F	M	F	M	F
GPA 1 Languages	17.22	<.01	10.06	<.01	-16.86	-10.18	13.20	11.25	8.59	-3.91
GPA 2 Soc. Std.	12.62	"	6.62	"	- 3.90	- 1.29	2.32	-2.48	-23.55	1.62
GPA 3 Mathematics	31.31	"	14.61	"	13.19	5.70	-0.23	-2.60	12.77	2.01
GPA 4 Science	27.14	"	18.67	"	18.57	10.60	-14.01	-2.86	4.35	-10.89
Lang. Not Taken	5.64	"	1.48	>.05	2.92	-0.10	-6.70	-3.89	1.19	-1.17
S.S. Not Taken	8.27	"	1.53	>.05	7.69	1.45	-2.53	-3.94	2.59	1.18
Math Not Taken	36.49	"	10.60	<.01	-14.70	-4.88	-1.97	5.30	3.66	-0.13
Science Not Taken	19.47	"	10.76	<.01	-11.06	-7.87	6.86	4.59	13.10	-2.14
Intel.Test Score	26.14	"	16.37	<.01	-0.37	7.27	15.44	4.95	-7.85	4.15
Normalized Rank	22.63	"	13.31	<.01	2.49	5.19	4.79	3.18	-6.54	14.88
Class Size	1.36	>.05	1.41	>.05	1.83	1.20	-1.68	0.00	5.26	-7.31
Public vs Private	5.55	<.01	1.71	>.05	-2.08	-5.99	-7.40	-4.74	-4.03	3.11
Denom. vs Indep.	2.80	.03	1.14	>.05	2.27	-1.62	-4.06	-4.37	2.23	6.28

Summary of Information from Phase I

Statistic	Male				Female			
	Root Number				Root Number			
	I	II	III	IV	I	II	III	IV
λ_i	.3257	.1486	.0358	.0151	.2942	.1115	.0404	.0134
Percent of Trace	62.03	28.29	6.82	2.87	64.03	24.27	8.79	2.91
Cumulative % Trace	62.03	90.32	97.14	100	64.03	88.30	97.09	100
Trace		.525				.459		
$\sqrt{\text{Trace}}$		.725				.677		
Canonical R ($\sqrt{\lambda_i}$)	.57	.38	.19	.12	.54	.33	.20	.12
Wilks' Λ		0.6246				0.6594		
F		9.46				4.72		
Degrees of Freedom		52 and 3,835				52 and 2163		
p		<.001				<.001		

Appendix F, Continued

Analysis 2: Five Physical Science Fields

Variable	Univariate F: F	Univariate F: p	Scaled Vectors: Vector I	Vector II	Vector III
GPA 1 Languages	2.48	<.05	- 7.94	- 4.21	- 3.12
GPA 2 Soc. Stud.	1.71	>.05	- 5.36	11.00	- 2.97
GPA 3 Math	13.68	<.01	16.07	- 2.31	- 0.71
GPA 4 Science	6.27	<.01	3.44	- 3.68	7.03
Lang. Not taken	4.74	<.01	6.11	4.49	0.51
S.S. Not taken	2.69	<.05	2.05	6.36	3.15
Math Not taken	1.86	>.05	0.48	- 5.82	- 3.35
Science Not tkn	0.71	>.05	0.46	0.34	- 3.01
Test Score	5.09	<.01	3.87	- 0.76	- 7.41
Rank in Class	4.11	<.01	0.68	- 2.48	2.48
Class Size	0.58	>.05	- 2.05	- 1.53	1.46
Public vs Private	2.36	.05	5.52	- 0.46	4.65
Denom. vs Indep.	3.63	<.01	1.52	- 5.63	5.41

Summary of Information from Phase I

Statistic	Root Number: I	II	III	IV
λ_i	.2073	.0907	.0448	.0178
Percent of Trace	57.48	25.14	12.42	4.95
Cumulative % Trace	57.48	82.62	95.04	99.99
Trace		.3606		
$\sqrt{\text{Trace}}$		.60		
Canonical R $(\sqrt{\lambda_i})$	.46	.30	.21	.13
Wilks' Λ		.714		
F		3.03		
Degrees of Freedom		52 and 1,737		
p		<.01		