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By-Lafferty, Gladys E.

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The purposes of the study were to determine the influence of age on academic achievement, to investigage meaningful relationships between Graduate Record Examination (GRE) aptitude test scores and graduate grade point ratios (GPR), and to evaluate the student sample in terms of national norms. The assumption underlying the study was that significant differences in the predictability of GRE aptitude test scores would result as a direct function of age. The sample consisted of 393 students who had received master's degrees during 1966 and 1967, in 18 different areas of specialization. Findings revealed that the assumption underlying the study could not be substantiated. For the group as a whole, no significant differences in means of GRE total aptitude test scores or in mean graduate GPRs were found. The oldest group had a lowest GRE scores, showed a tendency to earn slightly lower quantitative ability scores than the younger students, but earned the highest graduate GPRs. For education students, GRE total scores were found to predict graduate GPRs better for those 30 years of age and above than for those in their twenties. Age had little correlation with GRE scores for the men, but it was associated with both GRE scores and GPRs for the women. The men and women in the sample exceeded the 1964-1967 national norms for their sexes in all instances, except for male performance in verbal ability. (WM)

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# A STUDY OF THE INFLUENCE OF AGE ON PREDICTABILITY OF GRADUATE RECORD EXAMINATIONS APTITUDE TESTS FOR SUCCESSFUL GRADUATE STUDENTS

by

Gladys E. Lafferty

Graduate Student

School of Education

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Dr. James A. Keith, Adviser

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## Introduction

In studies published to date, relatively little attention has been given to the influence of age as it relates to achievement in graduate school. With expected increases in the number of graduate applicants of more mature age, in keeping with current trends in education and business, the need for greater knowledge about the influence of age on achievement at the graduate level is essential. Research in this area, however, is sparce.

Existing studies, utilizing a variety of individual and multiple variables to predict success in graduate school, tend to focus on screening devices primarily of an intellective nature. Madaus and Walsh (1965), using a sample of 569 graduate students in a New England college, found a significant correlation of .22 between Graduate Record Examinations (Aptitude Tests) scores and graduate grade point ratios based on one semester's work. This finding accounted for only 4.84% of the variance in graduate achievement. The data yielded significant correlations between Aptitude Test scores and graduate grade point ratios for chemistry, education, economics, history, nursing, NSF math, and math institute. On the other hand, non-significant relationships were obtained for biology, English, math, languages, philosophy, and physics. The researchers concluded that Graduate Record

Examinations when subjected to regression analyses were inefficient predictors of success in their graduate school.

In another study, Robertson and Hall (1964) investigated seventy-three graduate students at a Florida college, correlating the Miller Analogies Test, Graduate Record Examination scores, undergraduate grade point ratios, peer ratings, comprehensive examination scores with faculty ratings on ability to earn a Ph.D. Weighted indices of mean Graduate Record Examination scores, Miller Analogies Test, and undergraduate grade point ratios (for junior and senior years) produced a significant .32 correlation with faculty ratings and a significant correlation of .54 with comprehensive examination scores. The correlation between undergraduate grade point ratios and faculty rating of .15, however, was not significant.

Capps and DeCosta (1957) at S. C. State College in Orangeburg who used several Graduate Record Examination scores (profile, aptitude, and Advanced Education) in combination with National Teachers Examination scores to predict graduate grade point ratios in four professional Education courses required of all students, found that the Advanced Education tests of GRE were the strongest predictors of GPR (.49), followed, in order of strength, by National Teachers Examination scores (.44), undergraduate GPR (.42), and GRE Aptitude Test scores (.34).

King and Besco (1960) studied relationships between GRE Aptitude Test scores and faculty ratings for 119 doctor-

al candidates receiving Research Foundation Fellowships in 1956 to 1958, finding a correlation of .34, significant at the 5% level, for verbal ability, but no significant relationship between the criterion (faculty ratings) and quantitative ability ranks. The researchers recommended that cutting scores for admissions be established on a departmental rather than a university-wide basis.

Only about a third of the recent studies have employed undergraduate grade point ratios as predictors of success in the graduate school despite the success reported by earlier investigators (Lannholm, 1967). One study by Eckhoff (1966) in Winona, Minnesota, however, used a combination of undergraduate GPR, Miller Analogies Test scores, and advanced Education scores to predict achievement for 185 secondary and 111 elementary majors in Education with respect to thirty or more quarter hours completed. He obtained a high correlation of .51 between undergraduate GPR and Miller Analogies Test scores and the criterion, graduate GPR, for secondary majors; also, he found a multiple correlation of .30 by combining undergraduate GPR and Advanced Education scores to predict graduate GPR for elementary majors. Eckhoff (1966) concluded that Miller Analogies Test scores were ineffectual in predicting success for subjects used in his study. Owens and Roaden (1966) at Ohio found that among several predictors--undergraduate GPR, Watson-Glaser Critical Thinking Appraisal Test, and the Ohio State University Psychological Test--the undergraduate GPR was the most effi-

cient of the three independent variables in predicting the criteria of graduate GPR and advisor ratings.

Diversity of instruments, methods, and criteria makes it difficult to compare findings of individual studies. The validity of predictive screening tests varies from test to test, from college to college, and even from department to department within the same institution. Generally, correlation coefficients obtained between such tests and success in graduate school range from zero to .40 (Willingham, 1965).

Among the most widely used screening instruments for graduate school admission, affording some degree of comparability among schools, are the Graduate Record Examinations (GRE) Aptitude Tests. The tests provide concrete, objective, and relatively easy reference points in evaluating a candidate's general educational achievement in the liberal arts and sciences with respect to graduate level work. The system of scaled scores (with a mean of 500 and a standard deviation of 100), based on measurements of The Basic Reference Group of 1952, is used for reporting achievement. Norms, constructed originally on the test scores of 3,035 college seniors at twenty-one colleges, have undergone recent revision. The new norms for 1964-67 (Educational Testing Service Handbook, 1967) are based on the experiences of more than 368,000 students throughout the United States.

Educational Testing Service (ETS), publisher and administrator of Graduate Record Examinations, recommends the use of the revised norms for reference purposes only, cau-

tioning that the Aptitude Tests were designed primarily to supplement rather than to substitute for other pertinent information about an applicant seeking admission to graduate school. Their chief value lies in how much they improve prediction, not how well they act alone.

The fact that GRE Aptitude Test scores are based on the performance of college seniors gives rise to speculation as to their applicability to students who have been away from academic life for an appreciable period of time--that is, to students who are older than the average college senior.

Age, represented by the number of years elapsing between the baccalaureate degree and application to graduate school, was used as a predictive variable with respect to success (GPR) in only one published study that could be found. The lone study, made at Sacramento State College by Johnson and Thompson (1962) reported a -.26 coefficient between age and graduate GPR for 298 students, a finding which denoted a trend toward lower graduate grade point ratios with higher age levels. Correlations between age and GPR for thirteen areas investigated at Sacramento indicated an inverse relationship between the two variables for seven of thirteen fields, a positive relationship for five fields, and a zero correlation for one. Significant correlations were obtained for history (.43), for social science (.71), and for physical education (-.50). Education was broken down into three subareas, listing a zero correlation between age and GPR for guidance; a .10 correlation for administration and supervi-

sion; and a .17 correlation for the other areas of education combined, (all three coefficients were non-significant). For the fields of art, business administration, English, mathematics, health, and psychology all were reported with negative, non-significant relationships between the two variables (age and GPR), except for health which was .13. In most cases, the numbers of students in various areas of specialization were small.

Recent psychological research dealing with the subject of age and mental abilities suggests that the learning curve, contrary to earlier views, does not necessarily descend with increases in age. Studies indicate that learning potential may extend well beyond middle age, especially for those who have kept pace, particularly in such areas as general information and vocabulary. In testing fifty-year old men using the Army Alpha Test, taken by the same subjects thirty-one years earlier, Owens (1953) found an increase in tested ability at the later age. Certain abilities such as arithmetic, analogies, and organization of spacial relations, however, are thought to decline after age 20 or 30, probably at varying rates (Jones, 1955). Testing results reflect, among many things, initial intellectual level of individuals tested, types of tests used, and populations studied (Bayley, 1955).

The purposes of the present study are: (1) to find out the influence of age on the predictability of GRE Aptitude Test scores; (2) to investigate general relationships

among GRE Aptitude Test scores and graduate grade point ratios (GPR); (3) to evaluate the sample in terms of national norms.

An underlying assumption is held: That significant differences in predictability of GRE Aptitude Test scores will result as a direct function of age.

## Procedures

All students who received a master's degree during the years of 1966 and 1967, totaling 443 in eighteen different areas of specialization, were identified. For each student the following information was collected: degree, field of specialization, total GRE Aptitude Tests score, Verbal Ability Test score, Quantitative Ability Test score, age upon taking first graduate course, sex, number of courses taken at this university to satisfy the master's program, and graduate grade point ratio based on only the degree program.

From the total number of master's degree recipients, fifty-four students were excluded: thirty were from foreign countries and twenty-four did not have Aptitude Test scores. The remaining students (N=393) constituted the sample.

A table was constructed classifying each of the 393 graduate students by age, sex, and field of specialization. The data were analyzed globally, pooling information for all students, then by sex, and finally by department.

For global study, the students were sorted into three age groups: the twenties (N=293), the thirties (N=61) and

the forties (N=36). Three students, in their fifties, were not included. Using analysis of variance, the different age groups were compared, (1) on means for the variable GRE total aptitude test scores; (2) on means obtained for the variable graduate grade point ratio. Differences in means were tested for significance.

By means of another procedure, using the Pearson product-moment technique, total aptitude test scores were correlated with graduate GPR, first for each age group in the total sample; second, for all male students (N=304); and third, for all female students (N=89). Level of significance was determined for each of the correlational coefficients.

To examine the data for possible sex differences, the sample (N=393) was divided into two groups: men (N=304) and women (N=89). By employing multiple linear regression, Pearson product-moment correlations were computed, resulting in matrices--one for each sex--showing relationships between each two variables used in the study, namely: total GRE Aptitude Test scores, verbal ability test scores, quantitative ability test scores, age, and graduate grade point ratios.

Statistical study of departments, individually, was somewhat restricted by insufficient numbers of older students. To compensate, however, a table was constructed listing nine of the most populous areas of concentration, showing averages of total aptitude test scores with corresponding averages of graduate grade point ratios for three age groups within each

department.

A detailed study, however, was made of one department--Education. Pooling all students in education, the sample (N=66) was separated into three age groups: the twenties (N=30), the thirties (N=17), and the forties-and-above (N=19). Using analysis of variance, the three different age groups were compared with respect to means, first, on the variable total aptitude test scores; and second, on the variable graduate grade point ratio. Differences among means were tested for significance.

Each of the three age groups in Education was further studied by means of Pearson product-moment correlations, using all variables. Relationships between predictors and criterion were examined and discussed and significant differences in predictability determined.

The four independent (predictor) variables used in the study were: total GRE Aptitude Test scores, GRE Verbal Ability Test scores, GRE Quantitative Ability Test scores, and age. The one dependent (criterion) variable was graduate grade point ratio (GPR). Major statistical tools used in the study included multiple linear regression and Pearson product-moment correlations; also simple analysis of variance. Statistical computations were performed on IBM No. 7040 machines by personnel at the U.S.C. Computer Center.

## Findings

Classification of students by age, sex, and area of

Table I.--Classification of All Students (N=393) by Age, Sex, and Field of Specialization

| | Age: 20's | | | Age: 30's | | | Age: 40's | | | Age:50's | | Totals | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fields | M | F | Tot. | M | F | Tot. | M | F | Tot. | M | F | M | F | Tot. |
| Education | 19 | 11 | 30 | 11 | 6 | 17 | 7 | 9 | 16 | - | 3 | 37 | 29 | 66 |
| Bus. Adm. | 68 | 1 | 69 | 7 | - | 7 | 3 | - | 3 | - | - | 78 | 1 | 79 |
| Math. | 33 | 9 | 42 | 13 | 4 | 17 | 2 | 2 | 4 | - | - | 48 | 15 | 63 |
| For. Lang. | 1 | 5 | 6 | - | 2 | 2 | 3 | 3 | 6 | - | - | 4 | 10 | 14 |
| Engineering | 22 | - | 22 | 3 | - | 3 | 3 | - | 3 | - | - | 28 | - | 28 |
| English | 17 | 20 | 37 | 1 | 2 | 3 | 1 | - | 1 | - | - | 18 | 23 | 41 |
| History | 14 | 2 | 16 | 2 | - | 2 | 1 | - | 1 | - | - | 17 | 2 | 19 |
| Psych. | 13 | 2 | 15 | 3 | - | 3 | - | - | - | - | - | 16 | 2 | 18 |
| Int. Studies | 4 | 2 | 6 | 3 | - | 3 | - | - | - | - | - | 7 | 2 | 9 |
| Econ. | 6 | - | 6 | 2 | - | 2 | 1 | - | 1 | - | - | 9 | - | 9 |
| Biol. | 16 | 3 | 19 | - | 1 | 1 | - | - | - | - | - | 16 | 4 | 20 |
| Account'g. | 7 | - | 7 | 1 | - | 1 | - | - | - | - | - | 8 | - | 8 |
| Geog. | 1 | - | 1 | - | - | - | 1 | - | 1 | - | - | 2 | - | 2 |
| Physics | 6 | - | 6 | - | - | - | - | - | - | - | - | 6 | - | 6 |
| Poli. Sci. | 5 | - | 5 | - | - | - | - | - | - | - | - | 5 | - | 5 |
| Chemistry | 2 | - | 2 | - | - | - | - | - | - | - | - | 2 | - | 2 |
| Journalism | 2 | 1 | 3 | - | - | - | - | - | - | - | - | 2 | 1 | 3 |
| Geology | 1 | - | 1 | - | - | - | - | - | - | - | - | 1 | - | 1 |
| Totals | 237 | 56 | 293 | 46 | 15 | 61 | 22 | 14 | 36 | - | 3 | 304 | 89 | 393 |

specialization (Table I) showed that about one-fourth of the sample (N=100) was age thirty and above. Of these one hundred students, two-thirds (N=68) were men and one-third (N=32) were women. Departments containing older students limited to the male sex were: business administration, engineering, history, psychology, international studies, economics, accounting and geology. In biology, the one older student was a female. In other departments, combinations of older men and older women occurred as follows: education, eighteen women and fifteen men; mathematics, six women and fifteen men, foreign languages, five women and three men; English, two women and two men. The distribution tended to limit analyses separately by departments, but it served as a guide in narrowing inferences that the procedures suggested.

First, an analysis of variance (Table II) was performed for GRE-Total Aptitude Test scores using 390 students grouped by age: the twenties (N=293), the thirties (N=61), and the forties (N=36). Three students in their fifties were not included. No significant differences in means of GRE-Total Aptitude Test scores among the three different age groups were found.

An analysis of variance for graduate grade point ratio (Table III) shows means and standard deviations for the same students (N=390) grouped by ages as in Table II. No significant differences in mean graduate grade point ratios among the three different age groups were revealed. However, from Table II and Table III it may be seen that the oldest group had the lowest mean GRE scores, but earned the highest graduate GPR. The observation was not statistically significant.

Table II.--Analysis of Variance for GRE-Total Aptitude Test Scores, for Students in their Twenties (N=293), Thirties (N=61), and Forties (N=36), Total Number 390

| | Age Groups | | |
|---|---|---|---|
| | 20's | 30's | 40's |
| Sample Size | 293 | 61 | 36 |
| Mean GRE Total Score | 1078.8 | 1093.6 | 1075.3 |
| Standard Deviation | 146.5 | 168.6 | 186.9 |

Analysis of Variance

| | Sum of Sqs. | df | Mean Sq. | F-Ratio | P |
|---|---|---|---|---|---|
| Between Groups | 12208.7751 | 2 | 6104.3876 | 0.2568 | Non-sig. |
| Within Groups | 9198145.5000 | 387 | 23767.8176 | | |
| Total | 9210354.2500 | 389 | | | |

Table III.--Analysis of Variance for Graduate GPR for Students in their Twenties (N=293), Thirties (N=61), and Forties (N=36), Total No. 390

| | Age Groups | | |
|---|---|---|---|
| | 20's | 30's | 40's |
| Sample Size | 293 | 61 | 36 |
| Mean Graduate GPR | 3.4423 | 3.4368 | 3.4881 |
| Standard Deviation | .3048 | .3072 | .2875 |

Analysis of Variance

| | Sum of Sq. | df | Mean Sq. | F-Ratio | P |
|---|---|---|---|---|---|
| Between Groups | 0.0731 | 2 | 0.0365 | 0.3959 | Non-sig. |
| Within Groups | 35.6732 | 387 | 0.0922 | | |
| Total | 35.7461 | 389 | | | |

To determine the degree of relationship between means of GRE tests and graduate GPR means for each of the age groups, Pearson product-moment correlations were computed, shown in Tables IV, V, and VI. For students in their twenties, GRE scores correlated with GPR at .1578, significant at the 1% level. Correlations between GRE scores and GPR for the other two groups (the thirties and forties) were .1551 and .1920, respectively, neither of which was significant. While all coefficients of correlation between GRE total scores and GPR were small, accounting for between two and four per cent of the variation in achievement (GPR), the relationship for the twenties, which contained the largest number of students and which reached the 1% level of significance, was (while very low) the most reliable coefficient.

Among the minor findings were the following observations: (1) no significant relationships were found between GRE total scores and age for any of the three age groups, but a trend toward negative directions was noted for the twenties and thirties; (2) no significant relationships were found between age and GPR for any of the age groups, but the direction for the twenties and forties was positive (but low); for the thirties negative; (3) relationships between age and verbal ability for the twenties was -.1692, an inverse relationship significant at the 1% level; for the thirties, the direction was positive but not significant; and for the forties, negative but not significant; (4) correlations between age and quantitative ability for the twenties and forties were positive but not significant; but, for the thirties the correlation of -.2894 indicated an inverse relationship significant at the 5% level.

Table IV.--Coefficients of Correlation Using GRE Total Scores, Verbal Scores, Quantitative Scores, Age, and Graduate GPR for all Students in their Twenties (N=293)

| | GRE-T | Verbal | Quan. | Age | Grad. GPR |
|---|---|---|---|---|---|
| GRE-Total | 1.0000 | .6863** | .7676** | -.0783 | .1578** |
| Verbal | | 1.0000 | .0667 | -.1692** | .1311* |
| Quan. | | | 1.0000 | .0434 | .0999 |
| Age | | | | 1.0000 | .0991 |
| Grad. GPR | | | | .0991 | 1.0000 |

** Significant at 1%
* Significant at 5%

Table V.--Coefficients of Correlation between GRE Total Scores, Verbal, Quantitative Scores, Age, and Graduate GPR, for All Students in their Thirties (N=61)

| | GRE-T | Verbal | Quan. | Age | Grad. GPR |
|---|---|---|---|---|---|
| GRE-Total | 1.0000 | .7323** | .8093** | -.1215 | .1551 |
| Verbal | | 1.0000 | .1926 | .1326 | .1018 |
| Quan. | | | 1.0000 | -.2894* | .1356 |
| Age | | | | 1.0000 | -.0206 |
| Grad. GPR | | | | -.0206 | 1.0000 |

** Significant at 1%
* Significant at 5%

Table VI.-- Coefficients of Correlation for GRE Total Scores, Verbal, Quantitative Scores, Age, and Graduate GPR, for All Students in their Forties (N=36)

| | GRE-T | Verbal | Quan. | Age | Grad. GPR |
|---|---|---|---|---|---|
| GRE-Total | 1.0000 | .8194** | .8604** | .0383 | .1920 |
| Verbal | | 1.0000 | .4129** | -.0534 | .2331 |
| Quan. | | | 1.0000 | .1084 | .0978 |
| Age | | | | 1.0000 | .1786 |
| Grad. GPR | | | | .1786 | 1.0000 |

** Significant at 1%
* Significant at 5%

A further study was made of the total sample (N=393) using Pearson product-moment correlations for selected variables: verbal scores, quantitative scores, age, and graduate grade point ratios. The results shown in Table VII suggest, for the total group, a low but positive relationship between age and verbal ability scores; and a low but negative relationship between age and quantitative ability. Table VII suggests also a closer relationship between verbal ability and GPR (.1430, significant at the 1% level) than quantitative ability with GPR (.1038, significant at the 5% level). As would be expected, verbal and quantitative abilities are significantly related (.1197, at the 5% level). The variable

Table VII.--Coefficients of Correlation for Verbal Scores, Quantitative Scores, Age, and Graduate GPR, for the Total Sample (N=393)

| | Verbal | Quan. | Age | Grad. GPR |
|---|---|---|---|---|
| Verbal | 1.0000 | 0.1197* | 0.0337 | 0.1430** |
| Quan. | | 1.0000 | -0.0801 | 0.1038* |
| Age | | | 1.0000 | 0.0169 |

**Significant at 1% level
* Significant at 5% level

of age, for the pooled data, however, is shown to have a very low relationship to any of the other variables used in the table.

An investigation by departments was somewhat restricted by inadequacies of the sample and by distribution patterns. Only in the area of education were total numbers even mini-

Table VIII.--Analysis of Variance for GRE Total Scores, for Education Students (N=66), by Age Levels: Twenties (N=30), Thirties (N=17), and the Forties-and-above (N=19)

| Age Groups | 20's | 30's | 40's and Above |
|---|---|---|---|
| Sample Size | 30 | 17 | 19 |
| Mean GRE Total | 957.67 | 995.24 | 1010.00 |
| Std. Deviation | 106.92 | 140.52 | 158.04 |

Analysis of Variance

| | Sum of Sqs. | df | Mean Sq. | F-Ratio | P |
|---|---|---|---|---|---|
| Between Groups | 35626.2324 | 2 | 17813.1162 | 1.0229 | Non-sig. |
| Within Groups | 1097091.6875 | 63 | 17414.1536 | | |
| Total | 1132717.9063 | 65 | | | |

Table IX.--Analysis of Variance for Graduate GPR for Education Students (N=66), by Age Levels: Twenties (N=30), Thirties (N=17), and the Forties-and-above (N=19)

| Age Groups | 20's | 30's | 40's and Above |
|---|---|---|---|
| Sample Size | 30 | 17 | 19 |
| Mean Grad. GPR | 3.3781 | 3.4779 | 3.3283 |
| Std. Deviation | .2823 | .3242 | .2776 |

Analysis of Variance

| | Sum of Sqs. | df | Mean Sq. | F-Ratio | P |
|---|---|---|---|---|---|
| Between Groups | .2080 | 2 | .1040 | 1.2178 | Non-sig. |
| Within Groups | 5.3796 | 63 | .0854 | | |
| Total | 5.5875 | 65 | | | |

mally acceptable for statistical analysis. An analysis of variance, therefore, was made of all education students (N=66), shown in Table VIII, giving means of GRE-total Aptitude Test scores for three different age groups: the twenties (N=30), the thirties (N=17), and the forties-and-above (N=19). Although the means differed appreciably among the three age groups, particularly between the youngest and the oldest age group, the differences did not reach statistical significance. The standard deviation for students in their forties-and-above bracket was relatively large indicating wide dispersion of scores in contrast to the small range for students in their twenties. Table IX, also based on the department of education, is an analysis of variance for graduate GPR using the same age groups appearing in Table VIII. By inspection, it may be seen that rather large differences occur between the thirties and the forties-and-above age groups; but the differences do not reach statistical significance.

To determine the degree of relationship between variables, particularly the magnitude of correlation between GRE scores and graduate GPR within each age group, Pearson product-moment correlations were computed, shown in Tables X, XI, and XII. The data revealed a significant relationship, at the 5% level, between GRE-Total scores and graduate GPR for students thirty and above. Conversely, for younger students (the twenties), no significant relationship was obtained between GRE total scores and graduate GPR. Another finding was that a significant relationship, but negatively

Table X.--Coefficients of Correlation for GRE scores, Age, and GPR, for Education Students in their Twenties (N=30)

| | GRE-T | Verbal | Quan. | Age | GPR |
|---|---|---|---|---|---|
| GRE-Total | 1.0000 | .7575** | .6914** | -.1424 | -.0309 |
| Verbal | | 1.0000 | .0521 | -.0272 | .2104 |
| Quan. | | | 1.0000 | -.1878 | -.2801 |
| Age | | | | 1.0000 | .1175 |
| GPR | | | | .1175 | 1.0000 |

** Sig. beyond 1%

Table XI.--Coefficients of Correlation for GRE scores, Age, and GPR, for Education Students in their Thirties (N=17)

| | GRE-T | Verbal | Quan. | Age | GPR |
|---|---|---|---|---|---|
| GRE-Total | 1.0000 | .6826** | .8542** | -.1686 | .4550* |
| Verbal | | 1.0000 | .2031 | .1228 | .3251 |
| Quan. | | | 1.0000 | -.3133 | .3783 |
| Age | | | | 1.0000 | -.0706 |
| GPR | | | | -.0706 | 1.0000 |

** Sig. at 1% level
* Sig. at 5% level

Table XII.--Coefficients of Correlation for GRE Scores, Age, and GPR, for Education Students in their Forties-and-above (N=19)

| | GRE-T | Verbal | Quan. | Age | GPR |
|---|---|---|---|---|---|
| GRE-T | 1.0000 | .8550** | .8390** | -.1309 | .4304* |
| Verbal | | 1.0000 | .4351* | -.3129 | .5683** |
| Quan. | | | 1.0000 | .1010 | .1509 |
| Age | | | | 1.0000 | -.4250*⊃ |
| Grad. GPR | | | | -.4250*⊃ | 1.000 |

** Sig. at 1% level
* Sig. at 5% level
*⊃ approaching 5% level

directed, existed between GPR and age for the forties-and-above group, at the 5% level. A further observation was a strong trend toward lower quantitative ability scores with age advances for the group in their thirties, and lower verbal ability scores with age advances for the forties-and-above category.

A comparison of verbal ability and quantitative ability scores with GRE-total scores for the various groups in education showed a stronger relationship of verbal ability with GRE-totals for both the twenties and the forties-and-above groups; but for the thirties, quantitative ability correlated higher with GRE-totals than did verbal ability.

As stated earlier, insufficient numbers of older students in most of the departments, except education, was a handicap impeding statistical analysis by areas. To compensate and to provide general information with respect to GRE scores and GPR relationships, averages were computed for nine departments and for total M.A. degree recipients and for total M.S. degree recipients. Within each department of the nine areas considered, three age groups were established as follows: (1) through age 24; (2) age 25 through 29; (3) age 30 and over. The age brackets were arbitrarily determined to afford maximum numbers at the oldest age level. Average GRE total scores accompanying average graduate GPR for each of the three age groups within nine departments are shown in Table XIII. The data showed that, in general, different levels of GRE scores appeared to be attached to different

Table XIII.--Nine of Eighteen Areas of Specialization by Recipients of Master's Degrees, 1966 and 1967, Showing Average GRE Total Scores, Average Graduate GPR, and Numbers of Students Involved, by Age Groups

| Area of Specialization | GRE Avg. | GPR Avg. | No. | Total |
|---|---|---|---|---|
| Mathematics | | | | 63 |
| Age 30 and beyond | 1224 | 3.398 | 21 | |
| Age 25 through 29 | 1142 | 3.588 | 28 | |
| Through age 24 | 1183 | 3.441 | 14 | |
| Engineering | | | | 29 |
| Age 30 and beyond | 1120 | 3.538 | 7 | |
| Age 25 through 29 | 1105 | 3.692 | 11 | |
| Through age 24 | 1135 | 3.295 | 11 | |
| English | | | | 40 |
| Age 30 and beyond | 1103 | 3.699 | 4 | |
| Age 25 through 29 | 1137 | 3.188 | 7 | |
| Through age 24 | 1137 | 3.487 | 29 | |
| Business Administration | | | | 79 |
| Age 30 and Beyond | 1179 | 3.376 | 10 | |
| Age 25 through 29 | 1055 | 3.399 | 14 | |
| Through age 24 | 1049 | 3.284 | 55 | |
| Biology | | | | 20 |
| Age 30 and beyond | 1050 | 3.294 | 1 | |
| Age 25 through 29 | 1027 | 3.286 | 3 | |
| Through age 24 | 1109 | 3.388 | 16 | |
| History | | | | 19 |
| Age 30 and beyond | 1050 | 3.346 | 3 | |
| Age 25 through 29 | 1063 | 3.308 | 6 | |
| Through age 24 | 1021 | 3.522 | 10 | |
| Psychology | | | | 18 |
| Age 30 and beyond | 956 | 3.202 | 3 | |
| Age 25 through 29 | 1093 | 3.309 | 3 | |
| Through age 24 | 1083 | 3.509 | 12 | |
| Education | | | | 66 |
| Age 30 and beyond | 1003 | 3.454 | 36 | |
| Age 25 through 29 | 941 | 3.378 | 18 | |
| Through age 24 | 983 | 3.378 | 12 | |
| Foreign Languages | | | | 14 |
| Age 30 and beyond | 965 | 3.720 | 8 | |
| Age 25 through 29 | - | (no cases) | 0 | |
| Through age 24 | 922 | 3.640 | 6 | |
| M.A. Degrees (all) | 1077 | 3.527 | | 126 |
| M.S. Degrees (all) | 1133 | 3.416 | | 51 |

*Fields not shown because of relatively small numbers include: International Studies, Economics, Accounting, Geography, Physics, Political Science, Chemistry, Journalism, and Geology. (See Table I for distribution.)

areas of specialization; for example, GRE averages for the departments of mathematics and engineering were 1100 or more while averages for the departments of education and foreign languages were 1000 or lower. Yet, average graduate GPR's did not vary consistently in accordance with differences in GRE levels. Lack of predictability of GRE averages was especially noticeable in such fields as mathematics, engineering, history, and English. On the other hand, higher GRE average scores appeared to occur with higher GPR averages in education, foreign languages, psychology and biology.

Although the numbers used in computing averages for age groups within departments were too small for confidence, the figures served in a general way to illustrate the variability of GRE scores and corresponding grade point averages. The data also lent support to a policy of setting cutting scores in admissions on a departmental basis rather than on a university-wide basis.

A final analysis was made in order to examine the data for possible sex differences. The total sample was divided into two groups, total men (N=304) and total women (N=89). Pearson product-moment coefficients were computed for each two variables, a procedure which yielded two matrices of values, one for men (Table XIV) and one for women (Table XV).

For men, no significant correlations were obtained between age and any other variable. The data yielded, however, a correlation of .1908 (significant at the 1% level)

between GRE total aptitude test scores and graduate GPR. The multiple correlation between four predictors (GRE total, verbal, and ability scores plus age) and GPR produced a correlation of .2018 which amounted to an increase of only .011. Thus, for male students, age appeared to add little improvement to GRE scores in predictive value. GRE total scores, accordingly, accounted for 3.64% of the variation in GPR and GRE scores plus age accounted for 4.07%, a difference of .63% judged to be negligible.

A minor finding was that quantitative ability for male students correlated with GPR at .1739 (significant at the 1% level), while verbal ability correlated with GPR at .1125, below the 5% level.

Table XIV.--Coefficients of Correlation for GRE scores, Age, and GPR, for all Male Students (N=304)

| | GRE-T | Verbal | Quan. | Age | Grad. GPR |
|---|---|---|---|---|---|
| GRE-T | 1.0000 | .7272** | .7913** | .0365 | .1908** |
| Verbal | | 1.0000 | .1613** | .0840 | .1125 |
| Quan. | | | 1.0000 | -.0226 | .1739** |
| Age | | | | 1.0000 | .0569 |
| Grad. GPR | | | | .0569 | 1.0000 |

**Sig. at 1% level

For women (Table XV), age was found to correlate negatively with each of the other four variables, as follows: -.1716 for age with GRE total aptitude test scores (slightly

Table XV.--Coefficients of Correlation between Variables for all Women Students (N=89)

| | GRE-T | Verbal | Quan. | Age | Grad. GPR |
|---|---|---|---|---|---|
| GRE-T | 1.0000 | .7876** | .8223** | -.1716 | .1147 |
| Verbal | | 1.0000 | .2971** | -.1990* | .1594 |
| Quan. | | | 1.0000 | -.0829 | .0287 |
| Age | | | | 1.0000 | -.1251 |
| Grad. GPR | | | | -.1251 | 1.0000 |

**Sig. at 1% level
*Sig. at 5% level

below the 10% level of significance, negatively directed); -.1990 for age with verbal ability (significant at the 5% level, negatively directed); -.0829 for age and quantitative ability (not significant); and -.1251 for age and GPR (negative, but not significant). Thus, for the sample of women represented, a tendency was shown for higher age levels to be associated with lower GRE scores and lower GPR.

An additional finding was that the correlation between GRE total scores and graduate GPR (.1147), for women, was not significant. But, when a multiple correlation using four predictors (GRE total scores, verbal and quantitative scores, plus age) for GPR was computed, a coefficient of .2617, significant beyond the 2% level, was obtained. For women, then, age was judged to have a significant effect on the predictability of GRE scores with respect to the criterion, grade point ratio. By combining age with GRE scores, the coefficient of correlation rose from .1147 to .2617

resulting in a substantial increase of .1470. GRE scores alone accounted for only 1.32% of the variation in GPR, while GRE scores plus age accounted for a significantly higher amount--6.85% of the variance.

Since the data have shown that the influence of age was attached to only one sex--women--and since older women were found to be in only five areas of specialization (education, mathematics, foreign languages, English, and biology, in different proportions), the identification of an age influence as an independent factor is not justified. An interaction possibly may be at work involving: (1) sex of the student; (2) area of specialization; (3) variables unidentified by the present study.

## Discussion and Conclusions

In view of the results obtained, the assumption underlying the present study restricted to only successful graduate students--that significant differences in predictability of GRE Aptitude Test scores would result as a direct function of age--was not substantiated. An analysis of three different age groups for the stratified sample revealed no significant mean differences in either GRE total scores or in graduate grade point ratios (Tables II and III). However, the relationship between GRE total scores and GPR's for students in their twenties, while low (r=.1578), was found to be significant at the 5% level; the relationships between GRE total scores and GPR's for students in their thirties and forties (r=.1551 and r=.1920, respectively), shown in Tables IV, V, and VI, were not significant.

With respect to all variables used in the study, age correlated poorest of all with the other components (Table VII). For the total sample as shown in Table VII, age correlated with verbal ability at .0337, with quantitative ability at -.0801, and with graduate GPR at .0169. The findings are not in agreement with those obtained at Sacramento by Johnson and Thompson (1962) who reported a correlation of -.26 between age and graduate GPR.

In the area of education, however, data were obtained showing a trend of possible age differences. While no significant mean differences were observed in GRE scores or GPR for students in three different age categories (Tables VIII and IX), sizeable differences in coefficients were found in predictability of GRE scores with respect to GPR among three age groups (Tables X, XI, and XII). For students in their twenties, no significant correlation resulted between GRE scores and GPR (-.0309); but for students in their thirties and forties-and-above definite, positive correlations between GRE total scores and GPR were obtained (.4550 and .4304, respectively, both significant at the 5% level). While these data appear to provide tangible support for age influences, the small numbers involved tend to limit confidence.

The relationships between GRE scores and GPR for education students in the present study were difficult to relate to findings reported elsewhere inasmuch as the populations and methods differed. In one study, however, by White (1954) who also used master's degree recipients, a correla-

tion of .40 between GPR and the combined verbal and quantitative scores was reported. This coefficient resembles those obtained in the present study for students in their thirties and forties-and-above (.4550 and .4304), but White's positive coefficient was not in accord with that of -.0309 for the twenties.

Small numbers of older students in departments other than education made statistical analysis by areas impractical. The expedient of using simple averages by age groups within a number of departments provided tenuous evidence of the unpredictability of GRE scores with respect to GPR (Table XIII). One characteristic, however, appeared to be consistent: different GRE levels were associated with different areas of specialization. For example, mean GRE scores differed considerably between such fields as engineering and education. King and Besco (1960), noting a comparable trend in their study, expressed the opinion that different skills (represented by different levels of GRE scores) might be more necessary for success in one field than another. The hypothesis expressed by King and Besco might help to explain the finding in the present study that M.A. recipients, despite lower mean GRE total scores than M.S. candidates, earned relatively higher GPR's.

One of the most unexpected findings of the present investigation, pertaining to women students, concerned relationships of variables which were distinctly different from those found for male students and for the group as a whole

(Table XV). For women, while their GRE scores alone were not significantly related to their GPR's (r=.11), a multiple correlation of all GRE scores plus age with GPR yielded a coefficient of .2617, significant beyond the 2% level. The multiple correlation, thus, accounted for 6.85% of the variance in graduate GPR, still leaving about 93% of the variability in the criterion unidentified.

For men, on the contrary, age contributed very little to the predictive value of GRE scores. GRE scores, alone, for men as a group, correlated with GPR at .1908, significant at the 1% level (Table XIV). A multiple correlation, using both GRE scores and age, yielded a coefficient of .2018, which improved prediction by only a fractional amount (.011). Four predictors, for men, accounted for only 4% of the variance in GPR, leaving about 96% of the variability in GPR unexplained.

The question arises with respect to the differences in the data for men and women: why would age affect the performance of women, but not that of men? Several hypotheses might be advanced: after many years in the role of homemaker removed from academic pressures, older women return to the university for certification and up-grading in their fields; or, many women may try to further their educational credentials along with commitments to careers and homes demanding priority; or perhaps many women pursue master's degrees without serious future objectives.

Another question arises concerning the low predictability of GRE scores. For the total sample (N=393), the correlation between GRE total scores and graduate GPR was .1639, significant at the 1% level, compared to .22 obtained by Madaus and Walsh (1965), .40 by White (1954), and .34 by Capps and Decosta (1957). In part, the discrepancies may be attributed to differences in samples and methods used. Most of the predictive studies concentrated on one sub-area of a major department, a practice which minimized canceling effects. In all studies, however, the size of coefficients and the level of significance were extremely sensitive to the number of cases involved and to the instruments used, as well as the criteria (Robertson and Hall, 1964). In addition, for students at the graduate level previous controls for intellective abilities, at least in theory, have been administered, screening out those with lower scholastic potential.

Assuming that graduate students have been screened with respect to intellective abilities, it is tempting to speculate that personality factors may be of greater consequence to success in graduate school than pure mental abilities, granted minimum requirements are met. Perhaps a portion of the 94-96% variance in GPR left unaccounted for by GRE scores might be explained by personal characteristics such as temperament, interest, motivation, work habits, study skills, and perseverance (Lavin, 1965; McCandless, 1967;

Eells, 1961).

A further observation with respect to personality variables is that students earning marginal scores may compensate by working harder in the classroom. Durnell (1954) found that very high scores on the Miller Analogies Test might not be so indicative of scholastic success in certain areas as scores closer to the mean. Rupiper (1959) found, however, that of twenty-five students in education at the University of Oklahoma successful ones scored higher on the GRE verbal and Advanced Education tests than the unsuccessful ones. Conversely, Heriot (1967), studying students at a local technical school, reported that drop-outs due to academic failure were not significantly different from other students in entrance examination scores. Lack of consensus on the reliability of screening devices is typical of the research.

In conclusion, several reservations and limitations of the data are evident: The failure of evidence to support a direct, generalized age influence may, in part, be a product of the stratified sample used, of the screening-out processes at work in admissions and in the classroom, and the neutralizing effects of combined data across departmental lines. Further, there is no way of knowing without replication studies what confidence may be placed in the one-study findings; and without supplementary investigations of all graduate students, including drop-outs, there is doubt whether or not the inferences stated throughout the paper

apply to graduate students in general. Generalization beyond the definition of the sample (successful graduate students receiving a master's degree) would be unwarranted at present; and, results obtained apply to groups rather than to specific individuals.

A fringe benefit of the study was the accumulation of data with which to make comparisons on 1964-67 national norms. Inspection of Table XVI, tabulating verbal, quantitative ability, and total scores for The 1952 Basic Reference Group, 1964-67 national norms, and means of GRE scores for students in the sample, shows that the 393 graduate students in the study scored favorably with respect to national norms, except for male performance in verbal ability.

## Summary

An analysis of GRE scores, graduate GPR, and age was made on the performances of 393 successful graduate students receiving a master's degree during a two year period to (1) evaluate the relationship of age and achievement; (2) to discover meaningful relationships between GRE scores and GPR; and (3) to assess the students' standing on national norms.

Predictor variables were total GRE Aptitude Test scores, GRE Verbal Ability scores, Quantitative Ability scores, and age; the criterion was graduate grade point ratio. Statistical tools were multiple regression analysis, Pearson product moment correlations, and analysis of variance.

The principal findings with respect to age were:

Table XVI.--Norms for Verbal and Quantitative Abilities of GRE Aptitude Tests, Showing The 1952 Basic Reference Group, the 1964-67 Norms Group, and U.S.C. Master's Degree Recipients for the Years 1966, 1967

| | Verbal Ability | | | Quantitative Ability | | |
|---|---|---|---|---|---|---|
| | Men | Women | Total | Men | Women | Total |
| *1952 Basic Reference Group: | | | | | | |
| Mean | 492 | 491 | 492 | 507 | 447 | 480 |
| Standard Deviation | 95 | 101 | 98 | 95 | 81 | 94 |
| Number of Seniors | 1,657 | 1,378 | 3,035 | 1,657 | 1,378 | 3,035 |
| *1964-67 Norms Group: | | | | | | |
| Mean | 519 | 529 | 522 | 561 | 469 | 529 |
| Standard Deviation | 124 | 127 | 125 | 132 | 117 | 134 |
| Number of Candidates | 241,468 | 126,188 | 368,903# | 241,433 | 126,163 | 368,842# |
| 1966 and 1967 Master's Degree Recipients, U.S.C.: | | | | | | |
| Mean | 505 | 553 | 516 | 580 | 508 | 564 |
| Standard Deviation | 95 | 89 | 96 | 107 | 97 | 109 |
| Number in Sample | 304 | 89 | 393 | 304 | 89 | 393 |
| Per cent Scoring Lower Than Candidates for 1964-67 Norms Group | 45% | 53% | 47% | 53% | 64% | 59% |

(#More than 1,200 candidates did not indicate sex on their registration forms.)

*GRE Handbook for the interpretation of GRE scores, 1967-68, pp. 6-7.

For the group as a whole, age was not related to GRE scores nor GPR to any significant degree, but older students showed a tendency to earn slightly lower quantitative ability scores than younger students. GRE total scores were found to predict GPR in a more reliable fashion for younger students than for older ones, but the proportion of variance in GPR accounted for was low.

For Education students, GRE total scores predicted GPR better for students thirty and above than for students in their twenties. For all age groups, achievement (GPR) was significantly related to good verbal ability, with the need accelerating as students advanced in age. Weaknesses in quantitative ability significantly related to GPR's, showed up in one age group in education--the group in their thirties.

For male students, age had little correlation with GRE scores or with GPR's considering the group as a whole.

For women students, age was associated with all measures of performance--GRE scores and GPR's. The trend reached significance with respect to verbal ability. Increases in age, for women, had greater relevance to GRE scores than to GPR's. By themselves, GRE scores did not predict GPR with any degree of confidence. When age was paired with GRE scores, however, reliable prediction of GRE was afforded. All predictors, however, accounted for only about 7% of the variability in GPR for women, leaving 93% of the variability in GPR unaccounted for.

Interaction was suspected involving age, a specific

sex (women), and certain areas in which women specialized (education, foreign languages, math, English, and biology); and possibly other variables unidentified.

The principal minor findings were:

General relationships between GRE scores and GPR included the following: For the sample as a whole, only about 3-7% of the variability in GPR could be explained by predictors used. Verbal ability for all students (combined) appeared to be more essential than quantitative ability to high achievement, although both abilities were significantly related to classroom success.

For men students, GRE scores were found to be reliable in forecasting GPR, but for only 4% of the variance in GPR, leaving about 96% unexplained. Quantitative ability, for men, was found to be relatively more important than verbal ability for achievement in the classroom.

For women students, as a group, GRE scores were not reliable in predicting GPR. Verbal ability tended to be more essential than quantitative ability in successful achievement. Age, as cited above, appeared related to all performances.

For departments, informal computations suggested that high total GRE scores were more essential for success in certain areas than in others; and higher GRE scores did not consistently result in higher GPR's.

Norms: The men and women in the sample exceeded the 1964-67 national norms for their sexes in all instances,

except one--male performance in verbal ability.

The paper discussed limitations of the sample, the possibility of obscuring special effects through pooling of data, the need for replication of the study to confirm results, and a recommendation for a supplementary investigation which would include drop-outs and other graduate students making lower GRE scores constituting a more representative population.

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