THE C.A.A.-NATIONAL TESTING SERVICE

Summary of Test Results and Comparisons with Success in Flight Training

Prepared

by

National Research Council
Committee on Selection and
Training of Aircraft Pilots

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LETTER OF TRANSMITTAL

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November 27, 1944

Dr. Dean R. Brimhall
Director of Research
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Washington, D.C.

Dear Dr. Brimhall:

Between June 20, 1942, and January 31, 1943, the Committee on Selection and Training of Aircraft Pilots conducted screening examinations of applicants for the Army phase of the War Training Service Civilian Pilot Training Program. The attached report, entitled The C.A.A.-National Testing Service, Summary of Test Results and Comparisons with Success in Flight Training, provides an analysis of data accumulated in the course of this testing program. This report was prepared and is submitted by the Committee on Selection and Training of Aircraft Pilots with the recommendation that it be included in the series of Technical Reports issued by the Division of Research, Civil Aeronautics Administration.

The significance of the analysis of the relationships between test scores and flight performance suffers from the fact that the population does not include those who failed to meet the minimum standards established for the selection of applicants for flight training. However, the data are of interest in showing the extent to which the tests predict differential performance in flight training of those who meet the minimum standards. More important still, are the findings on inter-relationships among the tests and on the influence of such factors as education, age, geographical areas upon selection and upon achievement in learning to fly.

Very truly yours,

Morris S. Viteles, Chairman
Committee on Selection and
Training of Aircraft Pilots
National Research Council

MSV:cv

FOREWORD

Between June 20, 1942, and January 31, 1943, the Committee on Selection and Training of Aircraft Pilots, under contract with the Civil Aeronautics Administration, conducted screening examinations of applicants for the Army phase of the War Training Service (Civilian Pilot Training Program). These were administered through the C.A.A.-National Testing Service established by the Committee on Selection and Training of Aircraft Pilots with headquarters at the University of Rochester.

In undertaking the responsibility for the administration of qualifying examinations, the Committee on Selection and Training of Aircraft Pilots agreed to prepare an analysis of the results of such examinations. Two non-technical reports summarizing the results of examinations given by the C.A.A.-National Testing Service have been submitted to the Civil Aeronautics Administration, (Civil Aeronautics Administration Division of Research Report No. 9, January 1943, and Report No. 19, August 1943). In addition, there has been prepared a detailed analysis of test scores in relation to preference for various types of training and hours of previous flight instruction (Civil Aeronautics Administration Division of Research Report No. 30, May 1944).

The present report includes a detailed examination of the distribution of test scores, of relationships among tests, and of the validity of the tests in differentially predicting the flight performance of those who met the minimum standards established for the acceptance of applicants for flight training. The report embodies data of significance in the evaluation of tests which have been employed not only in the screening program of the Civil Aeronautics Administration but also in the initial phase of the aviation cadet testing program of the U. S. Navy which was formulated, in part, on the basis of earlier research conducted by the Committee on Selection and Training of Aircraft Pilots.

The Executive Subcommittee of the Committee on Selection and Training of Aircraft Pilots participated actively in developing the pattern of the C.A.A.-National Testing Service. Experience in the operation of an earlier Standard Testing Program, involving the cooperation of psychologists in various parts of the country, contributed to the formulation and administration of the C.A.A.-National Testing Service. This earlier project, described in an unpublished "Preliminary Report on the Standard Testing Program," showed that qualified examiners were available and that they were willing and even eager to participate in a nation-wide screening program representing a contribution to the war effort.

The details of the C.A.A.-National Testing Service program were planned by the Chairman (M.S. Viteles) and the Director of Research (J. W. Dunlap) of the Committee on Selection and Training of Aircraft Pilots, in cooperation with Dr. Dean R. Brimhall, Director of Research, Civil Aeronautics Administration. The responsibility for the formulation of operating procedures and for the direct administration of the C.A.A.-National Testing Service at the University of Rochester was first assigned to J. W. Dunlap, Director of Research, and was later transferred to M. J. Wantman, Director of Testing,

Committee on Selection and Training of Aircraft Pilots. Acknowledgment is due to the 609 examiners, scattered throughout the United States, who actively participated in the work of examining over 62,000 applicants for flight training.

Members of the Rochester staff who contributed to the success of the C.A.A.-National Testing Service as well as to the accumulation of data embodied in this report include Morey J. Wantman, Robert C. Rogers, David V. Tiedeman, Leonard S. Kogan, and Glenn E. Taylor, Jr. The preparation of the present report has been a cooperative undertaking under the general direction of the Editorial staff of the Committee on Selection and Training of Aircraft Pilots with the help of the staff of the Statistical Unit at the University of Rochester. Pages 1-36 were originally prepared by L. S. Kogan, G. E. Taylor, Jr., D. V. Tiedeman, and M. J. Wantman. Pages 37-46 were written by L. Festinger, L. S. Kogan, H. S. Odbert, and S. Wapner.

Morris S. Viteles, Chairman
Committee on Selection and
Training of Aircraft Pilots

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SUMMARY

From June 20, 1942 to January 31, 1943 the C.A.A.-National Testing Service, set up by the National Research Council Committee on Selection and Training of Aircraft Pilots, administered a battery of tests for screening applicants for primary and secondary flight training in the C.A.A. War Training Service Program. The test battery, consisting of an Inventory of Personal Data for Prospective Pilots (B.I.), a Test of Mental Alertness (M.A.T.), a Test of Mechanical Comprehension (M.C.), and a Test of Aviation Information (A.I.), was administered by Chief Examiners appointed at each of 609 testing centers throughout the United States and the tests were forwarded to the central office located at the University of Rochester, Rochester, New York, for scoring.

The central office then "certified" those applicants who scored above predetermined cutting scores on each of the B.I., M.A.T., and M.C. Tests and reported the certification to the appropriate C.P.T. Coordinator in charge of the local W.T.S. training program.

Preliminary reports have presented data on each of the four phases into which the program was divided (see footnote 5, page 3). This report is a summary report based on an analysis of the test scores and related information on a standard group of 55, 776 cases selected from the total group of over 62,000 applicants tested. The report presents data on: (1) the standard group as a whole; (2) the per cent of elimination and score distributions of educational, age, geographical, and phase groups; (3) the interrelationships among the measures obtained, viz., test scores, hours of previous flight instruction, and age; (4) scores obtained by those applicants who took the battery a second time; and (5) the efficiency of the test battery in predicting successful completion of the C.P.T. primary flight training course.

The results of the investigation may be summarized as follows:

1. Analysis of the test scores and other data on the standard group of 55,776 cases tested during the four phases of the screening program revealed that:

   a. The predetermined cutting scores rejected approximately 30% of the applicants during each phase.

   b. Considering the total group, the M.A.T. rejected about twice as many applicants as the B.I. and more than twice as many as the M.C. In the case of the college group alone, the B.I. rejected the largest percentage.

   c. Differences were found among the groups in the four phases, as follows:

      (1) The percentage of cases with college training decreased from 43% in Phase I to 33% in Phase IV.

(2) The number of previous hours of flight training decreased from phase to phase.

(3) With the exception of the A.I., the mean test scores tended to be higher in the later phases.

(4) The Phase II group was the oldest and Phase IV the youngest.

d. Differences in per cent of certification of cases from the seven geographical reasons seem to be related to differences in educational level.

2. Analysis of the intercorrelations among the various measures revealed that:

a. The intercorrelations among the tests are positive but low, the highest for the total group being .446, between M.C. and A.I.

b. When the total group is broken down into phases, the Phase I group exhibits the highest test intercorrelations; when broken down into educational groups, the grade school group exhibits the highest test intercorrelations.

3. Analysis of the test scores of two groups of cases who were rejected on their first testing but who later retook the tests revealed that:

a. The mean test scores on the repeat testing increased significantly over those of the first testing. The mean repeat test scores on the M.C. and A.I. approximated those of the original scores of the total group.

b. The test-retest correlations of the four tests ranged from .53 (B.I.) to .79 (M.A.T.). These coefficients are probably underestimates of the reliability of the tests due to influences such as practice effects, coaching, changes in motivation, etc.

4. On a sample of 4549 cases, not including applicants who had failed to receive a passing score on the test battery, test performance was compared with criterion data on success in subsequent primary flight training. An analysis of biserial r's between test scores and pass-fail and Pearson r's between test scores and flight grades revealed that:

a. Each of four tests correlated positively with success in flight training.

b. The best test in the battery appears to be the A.I. with the M.C. next in predictive value. The superiority of the A.I., however, may be due to the fact that it was not used for screening purposes and hence its range of scores was not curtailed as much as in the case of the three tests.

c. When only certain selected failers or only cases from schools with some attrition are considered, the coefficients are not

raised to any great degree over those obtained when all the failers are considered.

Additional findings were that cases with flight hours previous to enrollment appear to have a better chance of completing the course successfully than those with no previous flight hours and that the mean age of the failers was higher than that of the passers.

M.A.T., and M.C. Tests and who, if previously tested and not certified, had not retaken the tests within six weeks of their last previous testing,[4] (5) reporting the certifications to the C.P.T. Coordinators, first by wire within twenty-four hours of the receipt of answer sheets in the Testing Service office, and subsequently by letter confirming the previous wire.

The Testing Service was initiated on June 20, 1942 and officially ceased operations on January 31, 1943. This period was divided into four phases to facilitate the analysis which was to be made of the Testing Service results. The first phase included applicants tested between June 20, 1942 and August 2, 1942; the second phase included applicants tested between August 3, 1942 and September 15, 1942; the third phase included applicants tested between September 16, 1942 and November 15, 1942; and the fourth phase included applicants tested between November 16, 1942 and January 31, 1943.

Over 62,000 applicants were tested by the C.A.A.-National Testing Service during its seven months of operation. It was stipulated that these applicants be men between the ages of 18 and 36. Applicants who were under 27 years of age were eligible only after they had been rejected by an Army Aviation Cadet Board. The candidates were tested by 609 Chief Examiners and the results were reported to 571 Coordinators distributed throughout the country.

At the examination session each applicant was required to fill out a registration card. This card furnished information regarding age, flight experience, and educational background. This information was used as an aid in selecting a standard group of applicants for investigation. The standard group consists of 55,776 applicants, or approximately 90 per cent of all candidates tested. Applicants were excluded from the standard group when: (1) they indicated on their registration cards that they were applying for glider training or some training other than primary or secondary training, (2) they were retaking the examinations, or (3) they failed to furnish all required information on their registration cards.

The purposes of this report are: (1) to present a description of the data obtained in the administration of the C.A.A.-National Testing Service; (2) to determine educational, age, geographical, and phase variations in score distributions; (3) to derive both practical and theoretical interpretations from the statistical analysis of the screening results; (4) to analyze the scores obtained when applicants took the test battery a second time; and (5) to study the efficiency of the test battery in predicting the success-

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[4]At the beginning of the Testing Service it became apparent that men who were not certified would retake the examinations in the hope of succeeding on the next trial. Since it was not feasible to stop this practice, it was hoped that an applicant's advantage through his familiarity with the tests could be lessened by requiring him to wait at least six weeks before he could be reconsidered for certification. Enforcing this regulation necessitated a check in the national registration file on all cases that entered the Testing Service office to insure disqualification when warranted. For a discussion of the scores of applicants who were reexamined, see Chapter IV.

THE C.A.A.-NATIONAL TESTING SERVICE

Summary of Test Results and Comparisons with Success in Flight Training

INTRODUCTION

In June, 1942 the C.A.A. War Training Service[1] requested the Committee on Selection and Training of Aircraft Pilots of the National Research Council to administer a battery of tests to aid in the selection of candidates for the Army phase of the Civilian Pilot Training Program. The Committee adopted the following paper-and-pencil tests for the screening process: (1) The Inventory of Personal Data for Prospective Pilots (B.I.), (2) The Test of Mental Alertness (M.A.T.), (3) The Test of Mechanical Comprehension (M.C.), and (4) The Test of Aviation Information (A.I.).[2] Because of the difficulties of procurement, mobility, and administration, psychomotor tests were not included in the battery.

Results of experimentation by the Committee on Selection and Training of Aircraft Pilots and the Bureau of Aeronautics of the U. S. Navy were considered in the selection of the tests for screening program and in setting the cutting score on each test. It was also decided that only applicants scoring above the cutting score on each of the three basic tests, viz. B.I, M.A.T., and M.C. would be "certified" as eligible for primary flight training.[3] Candidates for secondary training were required to score above the A.I. "cutting score" in addition to passing the other three tests in order to be certified. Civilian Pilot Training Coordinators who were responsible for supervising flight training at local airports throughout the country were instructed to reject men who were not "certified" with the exception that an applicant for secondary training who had many hours of flight instruction and experience could be enrolled by a coordinator who felt the candidate was promising material.

The C.A.A.-National Testing Service was established for the administration of the screening tests. Its central office was located at the University of Rochester, Rochester, New York. This office performed the following functions: (1) appointment of educators or psychologists who were not otherwise connected with the flight training program as Chief Examiners, (2) distribution of test supplies to the Chief Examiners, (3) scoring of tests, (4) certification of applicants who scored above the "cutting scores" on the B.I.,

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[1]Prior to December, 1942 the C.A.A. War Training Service was known as the C.A.A. Civilian Pilot Training Program.

[2]Throughout this report, these four tests will generally be referred to by the abbreviations in parentheses after each test name.

[3]As indicated on page 4 of this report, it was estimated that the cutting scores and the method of certification would result in the elimination of approximately 75% of the applicants.

ful completion of C.P.T. primary flight training.[5]

DESCRIPTION OF THE TESTS[6]

The Inventory of Personal Data for Prospective Pilots (B.I.) contains 150 questions which furnish biographical information about the applicant. Previous studies had shown that certain of the questions differentiated applicants who later successfully completed the primary flight training course from those who failed to do so.

The Test of Mental Alertness (M.A.T.) consists of 80 multiple-choice items designed to measure intellectual capacity. In the past, applicants for C.P.T. were required to have two years of college training. Since this rigid restriction was waived during the period of the National Testing Service, it was necessary to "screen" off those individuals who would be likely to "washout" of the training course because of possible difficulty in mastering ground school and flight instruction.

The Test of Mechanical Comprehension (M.C.) consists of 76 picture problems involving mechanical relationships. It has consistently been found that high scores on this test are associated with success in flight training.

The Test of Aviation Information (A.I.) consists of 200 objective questions involving the history, aerodynamics, and other aspects of flight.

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[5]A detailed statistical report on each phase of the National Testing Service has been submitted to the Executive Subcommittee. (These reports are in the Committee files.) Three preliminary reports on results of the C.A.A.-National Testing Service have already been released in the Technical Series of the C.A.A. Division of Research. See:

Report on C.A.A.-National Testing Service (First Phase: June 20, 1942 - August 2, 1942.) Washington, D. C.: C.A.A. Division of Research, Report No. 9, January 1943.

Report on C.A.A.-National Testing Service (Phase II: August 3 - September 15, 1942; Phase III: September 16 - November 15, 1942; Phase IV: November 16, 1942 - January 31, 1943.) Washington, D. C.: C.A.A. Division of Research, Report No. 19, August 1943.

Report on C.A.A.-National Testing Service (Previous Flight Training and Flight Training Preferences as Related to Pilot Screening Test Scores.) Washington, D. C.: C.A.A. Division of Research, Report No. 30, May 1944.

[6]The exact identity of the various tests cannot be revealed in the present report. The general nature of each test, however, can be inferred from the brief descriptions in this chapter.

In constructing this test it was hypothesized that a successful pilot is the one who has been interested in flying for some time and will show this interest by a relatively high score on the test. When the National Testing Service was established, less information was available on the validity of this test than on the other three. Therefore, no passing grade was set for applicants for primary flight training. Previous studies had shown that there was a significant difference between the mean score of secondary and primary course applicants. Therefore, applicants for secondary flight training were required to have a score which exceeded the mean score of the group of primary applicants previously studied in order to be certified. However, coordinators were allowed to enroll for secondary flight training non-certified applicants who had considerable flight experience if they considered these applicants very promising material.

The time allowed for each of the four tests was as follows:

1. B.I. - 60 minutes
2. M.A.T. - 20 minutes
3. M.C. - 60 minutes
4. A.I. - 75 minutes

With the exception of the M.A.T. the time limits of the tests were of sufficient length so that few applicants failed to complete the tests.

ANALYSIS OF TEST RESULTS

A. Factors Related to Elimination

1. Per cent of Elimination. The cutting scores on the battery of three tests, namely, the B.I., M.A.T., and M.C., were set at points designed so that failure on one or more of the three tests would occur in the case of 30 per cent of the candidates.[7] In Table 1 it may be observed that 27 per cent of all the applicants in Phase I were not certified. In succeeding phases the percentages were 30, 30, and 28. On the whole, therefore, it may be said that the Testing Service approached very closely the estimated rejection rate.

2. Educational ackground. The term "educational Background" as used in this report refers to the amount of formal education the applicant had received at the time he was tested. Thus, an applicant who indicated he had completed one or more years of college training was treated as having a college background; an applicant who had completed one to four years of high school study (but no college) was said to have a high school background; the remaining applicants who had not studied in high school constituted the grade school group.

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[7]The estimate of the percentage to be eliminated was based on an analysis of previous studies, especially in connection with the Naval Aviation Cadet Selection Program.

Table 1 indicates the educational backgrounds of the applicants in each phase. It is clear that applicants with high school background made up more than 50 per cent of the total group, the proportion increasing from phase to phase. The proportion of applicants with college background was largest in Phase I with the proportion decreasing from phase to phase. Applicants with only grade school backgrounds were in a decided minority in all phases.

TABLE 1

PER CENT OF APPLICANTS CERTIFIED AND UNCERTIFIED, ANALYZED BY PHASE AND BY EDUCATIONAL BACKGROUND

(Standard Groups)

Group*		Phase I	Phase II	Phase III	Phase IV	Total
College	Certified	34	30	30	29	31
	Uncertified	9	10	9	9	9
	Total**	43	40	39	38	40
High School	Certified	39	39	40	42	40
	Uncertified	15	18	18	19	18
	Total	54	57	59	60	57
Grade School	Certified	1	1	1	1	1
	Uncertified	2	2	2	1	2
	Total	3	3	2	2	3
Total	Certified	73	70	70	72	71
	Uncertified	27	30	30	28	29
	Total					
N		16,191	15,298	15,780	8,507	55,776

*See Section 2, (page 7) for definitions of educational background.

**As these percentages are rounded to the nearest whole number the "totals" do not always equal the sum of the certified and uncertified.

Table 2 presents in detail the distribution of educational background by phase. The per cent of applicants who had twelve or less years of schooling increased from phase to phase, the percentages being 57, 60, 61, and 62 in that order.

3. Eliminations by Each Test. It is interesting to note the proportion of applicants screened out by each of the three tests. Table 3 presents a comparison of these percentages in each of the four phases and for the total standard group of 55,776 applicants included in the analysis. The M.A.T. rejected about twice as many applicants as the B.I. and more than twice as many as the M.C. The percentages of uncertified cases who were below the M.A.T. cutting score were 17, 19, 19, and 17 respectively

TABLE 2

DISTRIBUTION OF EDUCATIONAL BACKGROUND BY PHASE

	Last School Year Completed	FREQUENCY Phase I	II	III	IV	Total	% AT AND BELOW EACH EDUCATIONAL LEVEL Phase I	II	III	IV	Total
	17 and over	538	436	452	217	1643	100	100	100	100	100
	16	1159	1075	1051	476	3761	97	97	97	97	97
College	15	805	711	655	311	2482	90	90	90	92	90
	14	2188	1837	1702	828	6555	85	85	86	88	86
	13	2254	2060	2293	1367	7974	71	73	76	78	74
	12	6623	6762	7265	4036	24686	57	60	61	62	60
High	11	1003	943	1015	608	3569	16	16	15	15	16
School	10	733	680	641	340	2394	10	10	9	8	9
	9	357	337	319	159	1172	5	5	4	4	5
	8	453	390	337	156	1336	3	3	2	2	3
Grade School	7 and under	78	67	50	9	204	*	*	*	*	*
	Median	11.83	11.77	11.76	11.74	11.78					
	N	16,191	15,298	15,780	8,507	55,776					

*Less than 0.5%

for the four phases and 13 for the total group. It should be noted that the total percentage of cases below the cutting scores, namely, 38% exceeds the 30 per cent total proportion of rejections. This is attributable to the fact that some applicants were below a cutting score on more than one test.

It should also be noted that a small proportion of the certified cases in each phase was below the cutting score on each test. This figure was appreciable in Phase I when 5 per cent of the total number of applicants were included in the certified group even though they fell below the cutting score on the M.A.T. In this phase, and to a lesser degree in Phase II, the board certifying the men was allowed to use its discretion in certifying applicants who had high scores on two of the three tests even though they were below the cutting score on the third. During Phase III the certification board, of its own accord, advocated the withdrawal of this discretionary power so that in the latter part of Phase III and in Phase IV only those men were to be certified who scored above the cutting scores on all three tests. There remained, however, a small percentage of men scoring below the cutting score who were certified as a result of clerical errors. This percentage never exceeded one-tenth of one per cent.

The proportions of applicants eliminated by each test varied with educational background. This is clearly shown in Table 4 where the percentages of each of the three educational groups scoring above and below the cutting scores on the three tests are given. It may be noted from Table 4 that the B.I. rejected more college applicants than the other two tests. In the high school and grade school groups more applicants were rejected by the M.A.T. than by the other two tests.

4. Factors Related to Certification. The very nature of the screening process causes the mean score for the certified group to exceed the mean score of the uncertified group on the three tests largely responsible for the selection of the certified group. Table 5 also shows, however, that on the A.I. as well, the mean score of the certified group exceeded the mean score of the uncertified group, although this test was used for screening only in the case of the secondary applicants (less than 9 per cent of the total number of applicants).[8]

The mean number of hours of previous flight training of the certified group exceeded the mean number of hours for the uncertified group in Phases I and II. For Phase III the mean hours of the uncertified group is slightly higher than the mean hours of the certified group. In Phase IV they are practically similar. On the other hand, the mean age of the certified group is lower than the mean age of the uncertified group for each of the four phases. With the one exception of flight hours in Phase III, it may therefore be concluded that the men who were younger and had more knowledge

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[8]In a study in which the scores of primary applicants were treated separately (for Phase III only), the certified group obtained a higher mean score on the A.I. than did the uncertified group. See Report No. 30, op. cit.

TABLE 3

PER CENT ABOVE AND BELOW CUTTING SCORES BY PHASE

(Standard Groups)

		CERTIFIED		UNCERTIFIED		TOTAL	
	Phase	% Above Cutting Score	% Below Cutting Score**	% Above Cutting Score	% Below Cutting Score	% Above Cutting Score	% Below Cutting Score
B.I.	I	72	1	17	9	89	11
	II	69	*	21	10	90	10
	III	70	*	20	9	91	9
	IV	72	*	20	8	92	8
	Total	71	*	19	9	90	10
M.A.T.	I	69	5	10	17	78	22
	II	69	1	11	19	80	20
	III	70	*	11	19	81	19
	IV	72	*	11	17	83	17
	Total	70	2	11	18	80	20
M.C.	I	73	1	19	7	92	8
	II	69	*	23	7	93	7
	III	70	*	23	7	93	7
	IV	71	*	21	8	92	8
	Total	71	*	21	7	92	8

N	I.	16,191
	II.	15,298
	III.	15,780
	IV.	8,507
	Total	55,776

*Less than 0.5%

**Below cutting score includes all frequencies at and below the cutting score.

Note: Because these percentages have been rounded, they do not always total 100%.

about aviation and more flight experience at the time they were screened tended to be included in the certified group. It will be recalled that certification was determined without direct regard for age and previous flight experience, or for A.I. scores except in the case of secondary applicants. The distributions for the six measures discussed here appear in Appendix I.

5. Stability of Findings. The relative stability, from phase to phase, of the mean scores of the total group for the variables in Table 5 is of interest. All possible differences for each of the measures in the four phases were computed and the significance (critical) ratio was

TABLE 4

PER CENT ABOVE AND BELOW CUTTING SCORE ON B.I., M.A.T., AND M.C. TESTS BY EDUCATIONAL GROUP

(Standard Groups)

	PER CENT		
	COLLEGE Group	HIGH SCHOOL Group	GRADE SCHOOL Group
B.I.			
Above Cutting Score	87	93	81
Below Cutting Score*	13	7	19
M.A.T.			
Above Cutting Score	90	76	32
Below Cutting Score	10	24	68
M.C.			
Above Cutting Score	94	92	85
Below Cutting Score	6	8	15
N	22,415	31,821	1,540

*Below cutting score includes all frequencies at and below cutting score.

determined for each difference. These differences and significance ratios are reported in Table 6.

Following the commonly accepted rule that a difference is statistically significant if it is three times its standard error, it may be observed that three of the six possible differences for the B.I. are significant. For the M.A.T., all six differences are significant. For the M.C., only two differences are significant. For the A.I. three of the differences have ratios above 3.0. For hours, all six ratios are well above 3.0, and for age, five of the six differences are significant. Thus, although the differences are small in magnitude, they cannot be attributed to chance.

The differences in mean test scores, hours of flight training, and age among the phase (Table 6) may be summarized as follows:

B.I. - Phases I to III similar; Phase IV group higher.
M.A.T. - Each succeeding phase superior to the preceding phase.
M.C. - Phase I lowest; other phases similar.
A.I. - Phase I highest; other phases similar.
Hours - Each succeeding phase less than preceding phase.
Age - Phases I and III similar; Phase II older; Phase IV younger.

TABLE 5

MEANS OF TESTS, HOURS, AND AGE BY PHASE

(Standard Groups)

M E A N

	Phase	Certified	Uncertified	Total
B.I.	I	9.40	6.98	8.76
	II	9.34	7.40	8.75
	III	9.35	7.43	8.78
	IV	9.37	7.68	8.89
	Total	9.36	7.34	8.78
M.A.T.	I	41.97	29.31	38.60
	II	42.72	30.69	39.07
	III	43.14	30.89	39.50
	IV	43.58	31.49	40.14
	Total	42.74	30.50	39.22
M.C.	I	52.32	45.04	50.39
	II	52.61	46.52	50.76
	III	52.63	46.47	50.80
	IV	52.32	46.31	50.61
	Total	52.49	46.08	50.64
A.I.	I	97.51	62.68	88.26
	II	94.56	68.05	86.50
	III	93.16	67.78	85.62
	IV	91.74	69.68	85.46
	Total	94.62	66.78	86.60
Hours	I	16.28	10.47	14.73
	II	9.45	8.44	9.14
	III	5.55	6.03	5.69
	IV	4.23	4.32	4.26
	Total	9.60	7.66	9.04
Age	I	25.33	26.39	25.61
	II	25.71	26.86	26.06
	III	25.25	26.46	25.61
	IV	24.32	25.54	24.67
	Total	25.26	26.42	25.59

TABLE 6

SIGNIFICANCE RATIOS FOR DIFFERENCES BETWEEN MEANS OF PHASES*

(Standard Groups)

		PHASE I	PHASE II	PHASE III	PHASE IV
	I		0.3	-0.7	-3.9
	II	0.01		-1.0	-4.2
B.I.	III	-0.02	-0.03		-3.3
	IV	-0.13	-0.14	-0.11	
	Mean	8.76	8.75	8.78	8.89
	I		-4.0	-7.7	-11.0
	II	-0.47		-3.7	-7.7
M.A.T.	III	-0.90	-0.43		-4.6
	IV	-1.54	-1.07	-0.64	
	Mean	38.60	39.07	39.50	40.14
	I		-4.6	-5.1	-2.3
	II	-0.37		-0.5	1.6
M.C.	III	-0.41	-0.04		2.0
	IV	-0.22	0.15	0.19	
	Mean	50.39	50.76	50.80	50.61
	I		4.4	6.9	6.3
	II	1.76		2.3	2.3
A.I.	III	2.64	0.88		0.4
	IV	2.80	1.04	0.16	
	Mean	88.26	86.50	85.62	85.46
	I		19.9	35.5	39.3
	II	5.59		15.6	20.7
Hours	III	9.04	3.45		7.1
	IV	10.47	4.88	1.43	
	Mean	14.73	9.14	5.69	4.26
	I		-7.7	0.0	12.9
	II	-0.45		7.6	19.0
Age	III	0.00	0.45		12.9
	IV	0.94	1.39	0.94	
	Mean	25.61	26.06	25.61	24.67

*In each matrix the section above the diagonal contains significance ratios; the portion below the diagonal contains the differences between phase means. In each case the mean of the later phase is subtracted from the mean of the earlier phase.

The mean scores of the B.I., M.A.I., and M.C. tests tended to be higher in the later phases. This may be due, in part, to increasing knowledge by the applicants concerning the nature of the tests, even though strict precautions were taken for guarding the test material throughout the testing program and these precautions appeared to be quite successful.

The decrease in mean hours of flight experience from phase to phase may be accounted for in part by a gradual depletion of the supply of men with flight experience applying for primary training. In addition, applicants for secondary training who had previously taken the tests for certification for primary training were not required to retake the test battery. This had the effect of reducing the number of secondary applicants tested and, therefore, the average number of hours for the total group in the later phases.

It is difficult to explain the increase of the mean age in Phase II over that of Phase I. It may have resulted from an announcement by Selective Service officials, during the period covered by Phase II, which prompted men in the older age groups to apply for enlistment in this type of aviation training.

Comparisons based on the six variables were made for the college, high school, and grade school groups. These are presented in Table 7, and in general follow the same pattern of increase and decrease from phase to phase as does the total group. It has already been observed from Table 1 that the educational background of the applicants tested varied from phase to phase. This suggests that the significant differences obtained for the total group among the phases may be accounted for in part by changes in the constitution of the groups with respect to educational background.

The differences among the means of the six variables of Table 7 for the three educational groups were tested for significance. The differences and the significance ratios are presented in Table 8. It may be observed at once that all the possible differences satisfy the rule for statistical significance. With the exception of the B.I. the higher the educational level of the group, the higher the mean test score. The high school group was the youngest and had the least number of previous flying hours.

6. Analysis by Geographical Regions. For administrative purposes, the War Training Service office divided the country into seven regions. The states included in these regions are shown in Table 9 and in Figure 1. Table 10 gives the per cent of applicants in each phase who were tested in each region along with the percentage of certified and uncertified cases in each region. Region 1 contributed the greatest number of applicants and the greatest number of certified cases to the total number of applicants. Region 3 contributed the next highest number of applicants and also the next highest number of certified cases. Region 7 contributed the lowest number of applicants and also the lowest number of certified cases.

TABLE 7

MEANS OF TESTS, HOURS, AND AGE BY PHASE AND BY EDUCATIONAL GROUP

		MEAN			
	Phase	College	High School	Grade School	Total
B.I.	I	8.46	9.06	7.59	8.76
	II	8.31	9.11	7.71	8.75
	III	8.37	9.09	7.82	8.78
	IV	8.49	9.15	8.37	8.89
	Total	8.40	9.10	7.77	8.78
M.A.T.	I	42.59	36.27	24.65	38.60
	II	43.03	36.91	26.90	39.07
	III	43.43	37.44	25.99	39.50
	IV	43.84	38.25	27.42	40.14
	Total	43.12	37.11	25.95	39.22
M.C.	I	51.29	49.82	47.78	50.39
	II	51.68	50.18	49.40	50.76
	III	51.88	50.20	47.89	50.80
	IV	51.65	49.99	49.77	50.61
	Total	51.61	50.06	48.50	50.64
A.I.	I	93.31	85.57	66.31	88.26
	II	90.76	84.44	68.79	86.50
	III	90.27	83.35	66.09	85.62
	IV	89.95	83.11	71.69	85.46
	Total	91.30	84.22	67.57	86.60
Hours	I	15.84	13.79	15.82	14.73
	II	8.91	9.09	13.13	9.14
	III	5.49	5.60	11.07	5.69
	IV	4.37	4.09	7.32	4.26
	Total	9.47	8.56	12.92	9.04
Age	I	25.74	25.32	28.66	25.61
	II	26.54	25.58	28.83	26.06
	III	26.31	25.02	28.77	25.61
	IV	25.57	23.96	29.10	24.67
	Total	26.09	25.09	28.78	25.59
N	I	6,944	8,716	531	16,191
	II	6,119	8,722	457	15,298
	III	6,153	9,240	387	15,780
	IV	3,199	5,143	165	8,507
	Total	22,415	31,821	1,540	55,776

TABLE 8

SIGNIFICANCE RATIOS FOR DIFFERENCES BETWEEN MEANS OF EDUCATIONAL GROUPS

	Educational Groups Compared (A - B)	Mean A	Mean B	Significance Ratio for Difference Between Means A and B
B.I.	Col. - H.S.	8.40	9.10	-31.5
	Col. - G.S.	8.40	7.77	9.5
	H.S. - G.S.	9.10	7.77	20.4
M.A.T.	Col. - H.S.	43.12	37.11	70.5
	Col. - G.S.	43.12	25.95	68.9
	H.S. - G.S.	37.11	25.95	45.3
M.C.	Col. - H.S.	51.61	50.06	25.1
	Col. - G.S.	51.61	48.50	15.6
	H.S. - G.S.	50.06	48.50	7.9
A.I.	Col. - H.S.	91.30	84.22	24.2
	Col. - G.S.	91.30	67.57	25.0
	H.S. - G.S.	84.22	67.57	17.7
Hours	Col. - H.S.	9.47	8.56	4.8
	Col. - G.S.	9.47	12.92	-5.0
	H.S. - G.S.	8.56	12.92	-6.4
Age	Col. - H.S.	26.09	25.09	22.0
	Col. - G.S.	26.09	28.78	-20.9
	H.S. - G.S.	25.09	28.78	-28.9

TABLE 9

C.A.A. -- REGIONS

(After C.A.A. War Training Service)

1	2	3	4
Delaware	Alabama	Illinois	Arkansas
District of Columbia	Florida	Minnesota	Louisiana*
Maine	Georgia	Michigan	New Mexico
Maryland	Mississippi	Kentucky	Oklahoma
Massachusetts	North Carolina	Indiana	Texas
New Hampshire	South Carolina	North Dakota	
New Jersey	Tennessee	Ohio	
New York		Wisconsin	
Pennsylvania			
Rhode Island			
Vermont			
Virginia			
West Virginia			
Connecticut			

5	6	7
Colorado	Arizona	Idaho
Iowa	California	Montana
Kansas	Nevada	Oregon
Nebraska	Utah	Washington
South Dakota		
Wyoming		
Missouri		

*New Orleans and Baton Rouge, Louisiana, are included here in Region 4. These two centers are in WTS Region 2.

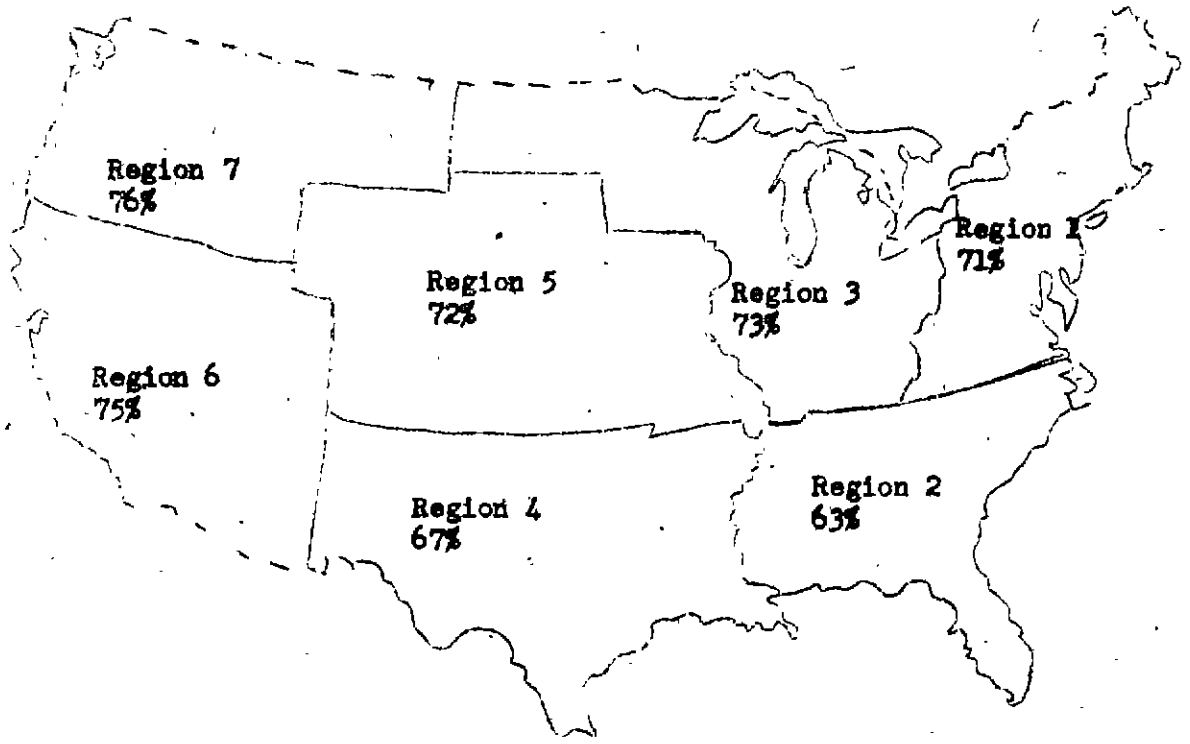

Figure 1

Map Showing Boundaries of Geographical Region and Per cent Certified in Each Region

TABLE 10

PER CENT OF APPLICANTS TESTED BY PHASE AND BY REGION

(Standard Groups)

Region		% OF EACH STANDARD GROUP Phase I	Phase II	Phase III	Phase IV	Total
1	Certified	15	11	12	20	14
	Uncertified	6	5	5	8	6
	Total*	21	16	18	28	20
2	Certified	8	6	6	4	6
	Uncertified	4	4	3	2	4
	Total	12	10	9	6	10
3	Certified	13	13	13	12	13
	Uncertified	4	5	5	5	5
	Total	17	18	19	17	18
4	Certified	12	11	9	7	10
	Uncertified	5	6	5	3	5
	Total	17	16	14	10	15
5	Certified	13	11	11	10	11
	Uncertified	4	5	4	4	4
	Total	17	16	15	15	16
6	Certified	7	12	13	12	11
	Uncertified	2	4	5	4	3
	Total	8	16	18	15	14
7	Certified	5	6	6	7	6
	Uncertified	1	2	2	2	2
	Total	7	8	9	9	8
Total	Certified	73	70	70	72	71
	Uncertified	27	30	30	28	29
	Total	--	--	--	--	--
N		16,191	15,298	15,780	8,507	55,776

* As these percentages are rounded to the nearest whole number the "totals" do not always equal the sum of the certified and the uncertified.

By inspection of the [illegible] in this table, it may be seen that the percentages contributed by each region varied from phase to phase. Thus while Region 1 contributed the largest number of applicants and the largest number of certified cases in the total testing program, Region 3 contributed the largest number of applicants and the largest number of cases for Phases II and III.

The percentage of applicants certified in each region is indicated in Table 11. Regions 6 and 7 had the greatest proportion of certified cases in every phase. The ranking of the regions according to the portion of their applicants certified is as follows: 7, 6, 3, 5, 1, 4, 2. The highest rate of certification appears in the far western states; the lowest rate in the southeastern states.

TABLE 11

PER CENT OF APPLICANTS CERTIFIED BY PHASE AND BY C.A.A. REGION

(Standard Groups)

Region		Phase I	Phase II	Phase III	Phase IV	Total
1	Certified	73	69	70	72	71
	Uncertified	27	31	30	28	29
	N	3,435	2,456	2,770	2,388	11,049
2	Certified	65	60	62	63	63
	Uncertified	35	40	38	37	37
	N	2,004	1,572	1,426	534	5,536
3	Certified	76	72	72	72	73
	Uncertified	24	28	28	28	27
	N	2,714	2,792	2,926	1,410	9,842
4	Certified	70	65	67	66	67
	Uncertified	30	35	33	34	33
	N	2,814	2,484	2,156	872	8,326
5	Certified	75	71	70	70	72
	Uncertified	25	29	30	30	28
	N	2,775	2,436	2,362	1,254	8,827
6	Certified	79	74	74	77	75
	Uncertified	21	26	26	23	25
	N	1,366	2,373	2,782	1,310	7,831
7	Certified	81	74	74	75	76
	Uncertified	19	26	26	25	24
	N	1,083	1,185	1,358	739	4,365

TABLE 12

TEST MEANS BY C.A.A. REGION

REGION		N	B.I.	M.A.T.	M.C.	A.I.
1	Certified	7870	9.51	43.28	51.29	95.45
	Uncertified	3179	7.43	31.78	44.20	68.75
	Total	11049	8.92	39.97	49.25	87.77
2	Certified	3484	9.19	41.14	51.74	90.79
	Uncertified	2052	7.22	28.79	45.59	60.85
	Total	5536	8.46	36.56	49.46	79.69
3	Certified	7195	9.52	43.23	52.36	95.87
	Uncertified	2647	7.48	30.87	45.59	69.03
	Total	9842	8.97	39.91	50.54	88.65
4	Certified	5606	8.97	41.97	52.56	90.03
	Uncertified	2720	7.02	30.19	46.66	62.76
	Total	8326	8.33	38.12	50.63	81.12
5	Certified	6346	9.16	42.65	52.77	90.75
	Uncertified	2481	7.18	30.82	46.92	63.63
	Total	8827	8.60	39.33	51.12	83.13
6	Certified	5906	9.60	43.13	53.53	102.50
	Uncertified	1925	7.72	29.84	47.29	75.10
	Total	7831	9.14	39.86	52.00	95.76
7	Certified	3306	9.50	42.91	53.88	95.11
	Uncertified	1059	7.40	30.29	48.22	69.35
	Total	4365	8.99	39.65	52.51	88.86

N = 55,776

Table 12 presents the test means according to C.A.A. regions. For three of the four tests, viz. B.I., M.C., and A.I., the two regions having the highest proportion of their groups certified (Regions 6 and 7) have the highest means. Regions 1 and 3, however, excelled the other regions on the M.A.T.

It is obvious that the regional differences discussed are a resultant of many factors. In an attempt to isolate some of these factors certain data were gathered from the 1940 census figures. These data are represented in Table 13.

Column 4 in this table shows the percentage of males eligible in age applying for training in each region. These percentages were computed by comparing the number of applicants from a region with the male population.

ages 15 to 34, for that region according to the 1940 census. This would make the age range from 17 to 36 in 1942 which would coincide with the age limits imposed by W.T.S.) It can be seen that the application rate was less than 1% of the males "eligible" in each region and that it varied from region to region. The percentage of eligible applicants was lowest in Region 1, and was higher in each successive region, reaching the highest value of 0.65% in Region 7.

Column 5 gives a rough indication of the average educational level of each region. As a measure of educational level of a state, the median number of years of school completed for men over 25 years of age was obtained. The average of these state medians was used to characterise the educational level of the particular region. Column 6 indicates the per cent of the population classified as urban in each region.

Table 14 presents the ranking of the several regions with respect to these census variables as well as with respect to the proportion of certified applicants and the ranks for the four test means. It will be noted that regions 6 and 7 which have the highest rate of certification also have the highest educational level and drew the greatest per cent of eligible males. Regions 2 and 4 show the lowest rate of certification, the lowest educational level, and lowest degree of urbanization.

Of the variables here considered, the educational level of the region appears most closely related to the per cent of certification. It is obvious, of course, that many other factors might be considered, such as the extent to which men were drawn into regular Army training.

7. Summary. Analysis of the test results and other data on 55,776 cases tested during the four phases of the screening program revealed that:

a. The predetermined cutting scores rejected approximately 30% of the applicants during each phase.

b. Considering the total group, the M.A.T. rejected about twice as many applicants as the B.I. and more than twice as many as the M.C. In the case of the college group separately, the B.I. rejected the largest percentage.

c. Differences were found among the groups in the four phases, as follows:

(1) The percentage of cases with college training decreased from 43% in Phase I to 38% in Phase IV.

(2) The number of previous hours of flight training decreased from phase to phase.

(3) With the exception of the A.I., the mean test scores tended to be higher in the later phases.

(4) The Phase II group was the oldest and Phase IV the youngest.

TABLE 13

CENSUS DATA ON C.A.A. REGIONS

Region	N	Male Population Age 15-34 (1940 Census)	Percentage of Males "eligible" in Age Applying	Average Years of Education	Per Cent Population Urban
1	11,049	7,355,056	0.15%	8.39	71.42
2	5,536	3,251,054	0.17%	7.09	31.93
3	9,842	5,506,866	0.18%	8.24	60.22
4	8,326	2,370,890	0.35%	7.60	39.57
5	8,827	1,853,804	0.48%	8.49	45.00
6	7,831	1,384,460	0.57%	9.15	67.25
7	4,365	671,609	0.65%	8.70	47.10

TABLE 14

RANKS OF C.A.A. REGIONS ON TESTING AND CENSUS VARIABLES

Region	% Certified	Mean B.I.	Mean M.A.T.	Mean M.C.	Mean A.I.	% of Eligible Population	Educ. Level of Region	% of Population Urban
1	5	4	1	7	4	7	4	1
2	7	6	7	6	7	6	7	7
3	3	3	2	5	3	5	5	3
4	6	7	6	4	6	4	6	6
5	4	5	5	3	5	3	3	5
6	2	1	3	2	1	2	1	2
7	1	2	4	1	2	1	2	4

d. Differences in rate of certification of cases from the seven geographical reasons seem to be related to differences in educational level.

B. Interrelationships Among Measures

1. Intercorrelations. When a battery of tests is used for selection, it is important that the interdependency of the constituent tests be clearly understood. If two tests are highly intercorrelated, it is probably inefficient to include both tests in a battery. Previous studies by both the Navy and the Committee had shown that a fairly low relationship exists among the B.I., M.A.T., and M.C. The exact extent of the relationship among the four tests in the battery is presented in Table 15, together with the relationship of the tests with the age and the number of flight hours that the applicant had when tested.

The intercorrelations of the tests are positive, but low, the correlation between the B.I. and M.A.T. approaching zero. The correlation between the M.C. and the A.I. is the highest, namely, .446. None of the tests correlates highly with hours and age although the Test of Aviation Information correlates .401 with hours. This latter correlation is in agreement with all previous experience with this test.

TABLE 15

INTERCORRELATIONS FOR STANDARD GROUP

	B.I.	M.A.T.	M.C.	A.I.	HOURS	AGE*
B.I.	—	.079	.257	.413	.264	-.111
M.A.T.		—	.351	.375	-.053	-.135
M.C.			—	.446	.084	.122
A.I.				—	.401	.073
Hours					—	.121
Age						—
Mean	8.78	39.22	50.64	86.60	9.04	25.59
σ	2.55	10.43	7.11	34.03	21.90	5.27

N = 55,776

*Intercorrelations of the variables with age are based on 55,682 cases.

Since these correlations are based on a sample of over 55,000 cases, one might expect them to be highly reliable even though it is clear from the discussion above that the sample of cases is made up of four groups that are not exactly comparable, e.g., Phase I contained many more secondary applicants than did the other phases. In order to determine the reliability of these correlations the intercorrelations of the measures (with the exception of age) were computed for the separate phases. These are presented in Table 16. The correlations in Table 16 are similar from phase to phase. Nevertheless, there are differences among the correla-

TABLE 16

INTERCORRELATIONS BY PHASE

	PHASE	B.I.	M.A.T.	M.C.	A.I.	HOURS
	I	--	.093	.271	.453	.316
	II	--	.070	.234	.400	.284
B.I.	III	--	.080	.256	.402	.227
	IV	--	.061	.277	.370	.212
	I		--	.368	.396	-.019
	II		--	.349	.363	-.060
M.A.T.	III		--	.357	.380	-.069
	IV		--	.307	.360	-.060
	I			--	.462	.120
	II			--	.425	.083
M.C.	III			--	.448	.064
	IV			--	.457	.070
	I				--	.491
	II				--	.399
A.I.	III				--	.322
	IV				--	.299
	I					--
	II					--
Hours	III					--
	IV					--
	I	8.76	38.60	50.39	88.26	14.73
	II	8.75	39.07	50.76	86.50	9.14
Mean	III	8.78	39.50	50.80	85.62	5.69
	IV	8.89	40.14	50.61	85.46	4.26
	I	2.64	10.69	7.19	35.94	27.69
	II	2.56	10.33	7.05	34.34	21.99
σ	III	2.51	10.30	7.07	32.66	16.54
	IV	2.43	10.29	7.15	32.03	14.22
	I = 16,191					
	II = 15,298					
N	III = 15,780					
	IV = 8,507					

tions that one would not have expected to occur in such large samples. All possible differences were therefore tested for statistical significance.[9] The significance ratios (t values) obtained in this operation are presented in Table 17 for the six possible phase differences for each intercorrelation.

A study of Table 17 indicates that two-thirds of the thirty possible correlation differences between Phase I and the other three phases are statistically significant. On the other hand, less than one quarter of the correlation differences among the other three phases were significant.[10]

In view of the fact that the mean and sigma values for each of the educational groups composing the total group of applicants differed from each other, the intercorrelations of the test battery for these three groups were obtained for each phase separately and also for the combination of the four phases. These correlations are presented in Tables 18-20 and 22-24.

The intercorrelations of the test battery for the total college group, the total high school group, and the total grade school group are similar to those obtained for the complete group of 55,776 applicants. It is interesting to note, however, that all but one of the test intercorrelations for the total grade school group are of greater magnitude than the corresponding ones for the group of all applicants (cf. Table 20 and Table 15). The largest difference between the test intercorrelations for the grade school group and the total group is that found for the correlations between the B.I. and M.A.T., the correlation

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[9] A t value of 3 or greater is considered as significant in the present report. The significance ratios of the differences between corresponding r's from phase to phase were computed by the formula:

$$t = \frac{z_1 - z_2}{\sqrt{(N_1 - 3) + (N_2 - 3)}}$$

where $z = \frac{1}{2} \log_e \frac{(1+r)}{(1-r)}$

For a more detailed discussion of the use of this test of significance, see: Fisher, R.A., Statistical Methods for Research Workers. Fifth Edition. Edinburgh: Oliver and Boyd, 1934, pp. 183-192.

[10] The fact that the Phase I intercorrelations were higher than those of the other three phases may be due to the greater variability of the Phase I group, as shown by the larger sigma values as presented in Table 16.

TABLE 17

t VALUES FOR PHASE DIFFERENCES BETWEEN INTERCORRELATIONS

	DIFFERENCES IN r's FOR PHASES	M.A.T.	M.C.	A.I.	HOURS
	I-II	2.1	3.5	5.7	7.6
	I-III	1.2	1.4	5.6	13.1
	I-IV	2.4	-0.5	7.5	12.1
B.I.	II-III	-0.9	-2.1	0.2	5.4
	II-IV	0.7	-3.4	2.6	5.7
	III-IV	1.4	-1.7	2.8	1.2
	I-II		1.9	3.4	3.6
	I-III		1.1	1.7	4.5
	I-IV		5.1	3.1	3.1
M.A.T.	II-III		-0.8	-1.7	0.8
	II-IV		3.5	0.3	0.0
	III-IV		4.2	1.7	-0.7
	I-II			4.1	3.3
	I-III			1.6	5.0
	I-IV			0.5	3.8
M.C.	II-III			-2.5	1.7
	II-IV			-2.9	1.0
	III-IV			-0.8	-0.4
	I II				10.2
	I III				18.2
	I IV				17.1
A.I.	II III				7.8
	II IV				8.4
	III IV				1.9

TABLE 18

INTERCORRELATIONS FOR TOTAL COLLEGE GROUP

	B.I.	M.A.T.	M.C.	A.I.	HOURS
B.I.	---	.111	.286	.436	.276
M.A.T.		---	.349	.343	-.030
M.C.			---	.454	.079
A.I.				---	.414
Hours					---
Mean	8.40	43.12	51.61	91.30	9.47
σ	2.59	9.79	7.19	33.56	21.75

N = 22,415

TABLE 19

INTERCORRELATIONS FOR TOTAL HIGH SCHOOL GROUP

	B.I.	M.A.T.	M.C.	A.I.	HOURS
B.I.	---	.102	.261	.422	.271
M.A.T.		---	.320	.355	-.075
M.C.			---	.428	.089
A.I.				---	.400
Hours					---
Mean	9.10	37.11	50.06	84.22	8.55
σ	2.48	9.76	6.95	33.67	21.74

N = 31,821

TABLE 20

INTERCORRELATIONS FOR TOTAL GRADE SCHOOL GROUP

	B.I.	M.A.T.	M.C.	A.I.	HOURS
B.I.	---	.253	.302	.457	.243
M.A.T.		---	.378	.455	-.025
M.C.			---	.409	.071
A.I.				---	.421
Hours					---
Mean	7.77	25.95	48.50	67.57	12.92
σ	2.50	9.43	7.58	36.21	26.37

N = 1,540

being .253 for the total grade school group as compared with the corresponding value of .079 for the total group of applicants.

The higher test intercorrelations in the case of the grade school group may be due to the fact that in a low education level group the "ability to take a paper test" is a strong common factor affecting performance on all the tests.

The differences between the corresponding correlations for the college, high school, and grade school groups were tested for significance. The t values are presented in Table 21. It can be seen that less than one-third of these differences have statistical significance. Half of the differences that have statistical significance involve the correlations between the B.I. and M.A.T. test and the correlation between the M.A.T. test and the A.I. Thus, the M.A.T. score was involved in six of the eight differences that proved to be significant. This is in keeping with the previous observation that the three educational groups showed the greatest relative differences on the M.A.T.

TABLE 21

t VALUES OF DIFFERENCES BETWEEN CORRELATIONS FOR COLLEGE, HIGH SCHOOL, AND GRADE SCHOOL GROUPS

	GROUPS COMPARED FOR DIFFERENCES IN r's	t - VALUES			
		M.A.T.	M.C.	A.I.	HOURS
B.I.	Coll. - H.S.	1.1	3.1	2.0	0.6
	Coll. - G.S.	-5.6	-0.7	-1.0	1.3
	H. S. - G.S.	-6.0	-1.7	-1.7	1.1
M.A.T.	Coll. - H.S.		3.7	-1.6	5.2
	Coll. - G.S.		-1.3	-5.1	-0.2
	H. S. - G.S.		-2.5	-4.6	-1.9
M.C.	Coll. - H.S.			3.7	-1.1
	Coll. - G.S.			2.1	0.3
	H. S. - G.S.			0.9	0.7
A.I.	Coll. - H.S.				1.9
	Coll. - G.S.				-0.6
	H. S. - G.S.				-1.2

Tables 22-24 present the intercorrelations of the test battery for the college, high school, and grade school groups by phases. An inspection of these tables indicates that the changes in correlation values from phase to phase were generally as large within the educational group as they were in the group of all applicants.

The correlations for the grade school group reported in Table 24 are based on a much smaller sample of cases than are the correlations for either of the other two groups, e.g., the correlations for the grade school group in Phase IV are based on only 165 cases.

The phase fluctuations of the intercorrelations for the grade school group were tested for statistical significance. The t values of the differences from phase to phase are presented in Table 25. Only 3 of the 60 possible differences had t values greater than 3.0, the highest being 3.7.

TABLE 22

INTERCORRELATIONS FOR COLLEGE GROUPS BY PHASE

	PHASE	B.I.	M.A.T.	M.C.	A.I.	HOURS
	I	--	.117	.285	.473	.327
	II	--	.098	.263	.413	.307
B.I.	III	--	.109	.295	.429	.215
	IV	--	.132	.324	.403	.218
	I		--	.371	.364	-.001
	II		--	.337	.324	-.040
M.A.T.	III		--	.348	.340	-.041
	IV		--	.323	.353	-.021
	I			--	.470	.116
	II			--	.409	.075
M.C.	III			--	.473	.059
	IV			--	.482	.086
	I				--	.512
	II				--	.392
A.I.	III				--	.335
	IV				--	.302
	I					--
	II					--
Hours	III					--
	IV					--
	I	8.46	42.59	51.29	93.31	15.84
	II	8.31	43.03	51.68	90.76	8.91
Mean	III	8.37	43.43	51.88	90.27	5.49
	IV	8.49	43.84	51.65	89.95	4.37
	I	2.68	9.93	7.26	35.17	27.28
	II	2.55	9.76	7.12	34.00	21.31
σ	III	2.53	9.75	7.13	32.09	15.83
	IV	2.57	9.55	7.24	31.68	14.28
	I = 6,944					
	II = 6,119					
N	III = 6,153					
	IV = 3,199					

TABLE 23

INTERCORRELATIONS FOR HIGH SCHOOL GROUPS BY PHASE

	PHASE	B.I.	M.A.T.	M.C.	A.I.	HOURS
	I	-	.105	.278	.458	.326
	II	-	.105	.237	.415	.277
B.I.	III	-	.114	.258	.414	.247
	IV	-	.070	.281	.377	.217
	I		-	.335	.367	-.051
	II		-	.332	.352	-.073
M.A.T.	III		-	.324	.366	-.078
	IV		-	.276	.336	-.082
	I			-	.441	.123
	II			-	.422	.089
M.C.	III			-	.417	.074
	IV			-	.440	.068
	I				-	.484
	II				-	.411
A.I.	III				-	.322
	IV				-	.304
	I					-
	II					-
Hours	III					-
	IV					-
	I	9.06	36.27	49.82	85.57	13.79
	II	9.11	36.91	50.18	84.44	9.09
Mean	III	9.09	37.14	50.20	83.35	5.60
	IV	9.15	36.26	49.99	83.11	4.09
	I	2.57	9.93	7.02	35.68	27.89
	II	2.51	9.60	6.87	33.95	22.16
σ	III	2.45	9.62	6.91	32.40	16.57
	IV	2.31	9.90	7.03	31.80	14.07

	I	= 8,716
	II	= 8,722
N	III	= 9,240
	IV	= 5,143

TABLE 24

INTERCORRELATIONS FOR [illegible] SCHOOL GROUPS BY PHASE

	PHASE	B.I.	M.A.T.	M.C.	A.I.	HOURS
B.I.	I	-	.266	.303	.498	.251
	II	-	.278	.367	.469	.311
	III	-	.236	.273	.393	.212
	IV	-	.145	.124	.418	.183
M.A.T.	I		-	.341	.497	-.045
	II		-	.434	.452	.034
	III		-	.408	.444	-.002
	IV		-	.181	.339	-.131
M.C.	I			-	.435	.054
	II			-	.469	.142
	III			-	.373	.083
	IV			-	.170	-.126
A.I.	I				-	.430
	II				-	.474
	III				-	.441
	IV				-	.273
Hours	I					-
	II					-
	III					-
	IV					-
Mean	I	7.59	24.65	47.78	66.31	15.82
	II	7.71	26.90	49.40	68.79	13.13
	III	7.82	25.99	47.89	66.09	11.07
	IV	8.37	27.42	49.77	71.69	7.32
σ	I	2.49	9.16	7.40	37.82	29.16
	II	2.53	9.83	8.07	36.96	26.84
	III	2.51	8.93	7.36	34.70	24.35
	IV	2.35	9.76	6.75	33.75	17.35
N	I = 531					
	II = 457					
	III = 387					
	IV = 165					

TABLE 25

t - VALUES FOR PHASE DIFFERENCES BETWEEN INTERCORRELATIONS FOR GRADE SCHOOL GROUPS

	DIFFERENCES IN r's FOR PHASES	t - VALUES M.A.T.	M.C.	A.I.	HOURS
	I -II	-0.2	-1.1	0.6	-1.0
	I -III	0.5	0.5	2.0	0.6
	I -IV	1.4	2.1	1.1	0.8
B.I.	II -III	0.6	1.5	1.3	1.5
	II -IV	1.5	2.8	0.7	1.5
	III -IV	1.0	1.7	-0.3	0.3
	I -II		-1.7	0.9	-1.2
	I -III		-1.2	1.0	-0.6
	I -IV		1.9	2.1	1.0
M.A.T.	II -III		0.5	0.1	0.5
	II -IV		3.1	1.5	1.8
	III -IV		2.7	1.3	1.4
	I -II			-0.7	-1.4
	I -III			1.1	-0.4
	I -IV			3.3	2.0
M.C.	II -III			1.7	0.9
	II -IV			3.7	2.9
	III -IV			2.3	2.2
	I -II				-0.9
	I -III				-0.2
	I -IV				2.0
A.I.	II -III				0.6
	II -IV				2.6
	III -IV				2.1

Little evidence is here offered that the samples of grade school applicants are not comparable from phase to phase. Fluctuations between phases for the high school and college groups appeared too slight to justify tests of statistical significance.

2. Summary. Analysis of the intercorrelations among the various measures revealed that:

a. The intercorrelations among the tests are positive but low, the highest for the total group being .446, between M.C. and A.I.

b. When the total group is broken down into phases, the Phase I group exhibits the highest test intercorrelations; when broken down into educational groups, the grade school group exhibits the highest test intercorrelations.

REPEAT STUDY

It has been previously stated that applicants who were not certified were eligible for reexamination after six weeks. Since many applicants took advantage of this opportunity, a sample of repeat cases became available for study.

The investigation of "repeat" scores was done in two separate studies so that an estimate of the stability of the results was possible. Study A consisted of 367 cases who were not certified in Phase I and retook the examinations in Phase II. Study B consisted of 1304 cases who were rejected in either Phase III or IV and later retook the tests. The original and repeat mean scores for the group reexamined and the mean scores for the total population of 55,776 cases are presented in Table 26.

TABLE 26

"ORIGINAL" AND "REPEAT" MEANS OF THE REEXAMINED APPLICANTS

VARIABLE	ORIGINAL TESTS A	ORIGINAL TESTS B	REPEAT TESTS A	REPEAT TESTS B	TOTAL POPULATION
B.I.	7.06	7.54	8.19	8.44	8.78
M.A.T.	30.74	31.03	37.41	37.93	39.22
M.C.	47.44	47.38	50.22	50.21	50.64
A.I.	72.32	72.50	86.34	86.69	86.60
N	367	1304	367	1304	55,776

It is apparent that the mean original scores of the reexamined group are different from the mean scores of the total population. This was to be expected since this repeat group was made up of applicants who had fallen

at or below the cutting scores of at least one of the tests. When these applicants retook the test battery, however, their scores increased. In fact, the mean scores for the repeat tests were not significantly different from the mean scores for the total population in the case of the M.C. and A.I.

The significance ratios in Table 27 for the differences between mean scores for the original test and mean scores for the repeat test are all greater than 5.0, which indicates that the chances are less than 1 in 10 million that the difference is not a real one. The highest ratio, 17.1, occurs for the difference in M.A.T. scores and the lowest ratio, 8.5, occurs for the difference in B.I. scores. It is, therefore, evident that an average improvement in all test scores results when an applicant is permitted to repeat the tests.

TABLE 27

SIGNIFICANCE RATIOS FOR THE DIFFERENCES BETWEEN ORIGINAL AND "REPEAT" MEANS OF TWO SAMPLES

	DIFFERENCES IN MEANS BETWEEN:	SIGNIFICANCE RATIOS STUDY A	STUDY B
B.I.	Total Group and Original Scores of Repeat Group	12.8	15.9
	Total Group and Repeat Scores of Repeat Group	4.5	4.6
	Original Scores and Repeat Scores of Repeat Group	-6.0	-8.5
M.A.T.	Total Group and Original Scores of Repeat Group	16.4	29.6
	Total Group and Repeat Scores of Repeat Group	3.2	4.3
	Original Scores and Repeat Scores of Repeat Group	-8.8	-17.1
M.C.	Total Group and Original Scores of Repeat Group	8.4	16.4
	Total Group and Repeat Scores of Repeat Group	1.1	2.1
	Original Scores and Repeat Scores of Repeat Group	-5.3	-10.0
A.I.	Total Group and Original Scores of Repeat Group	9.5	17.4
	Total Group and Repeat Scores of Repeat Group	0.2	-0.1
	Original Scores and Repeat Scores of Repeat Group	-6.4	-12.0

The test intercorrelations are presented in Table 28. The intercorrelations of the original B.I. score and the original M.A.T. score are -.457 for Study A and -.447 for Study B. These intercorrelations were so different from the .079 correlation of these two variables in the total population (Table 15) that further investigation was made in Study A of this negative relationship. In general, an applicant fell at or below the cutting score of only one test (only 15 per cent of the reexamined cases fell at or below the cutting score of more than one test in their original attempt). Of the 367 applicants 35 per cent were below the B.I. cutting score, 61 per cent were below the M.A.T. cutting score, and only 10 per cent were below the M.C. cutting score. It is, therefore, apparent that these two tests, the B.I. and the M.A.T., accounted, in a large measure, for the original rejection of this group. Of the 352 applicants scoring below either the B.I. or M.A.T. cutting score only 6 per cent scored below the cutting scores of both tests. The negative relationship between these two tests is now evident since 332 of the 367 applicants either scored above the B.I. cutting score and below the M.A.T. cutting score or vice versa. It is probable that a similar explanation can be applied to other reverse relationships in Table 28.

The test-retest correlations of the four tests appear in the blocked-in diagonal in Table 28. If these correlations are taken to be indices of reliability, the tests rank in the following order of reliability: M.A.T., A.I., M.C., B.I. This rank order was consistent for both studies. Although the A.I. and M.C. retest correlations consistently ranked lower than the M.A.T. coefficients, the difference between the three pairs of coefficients was not appreciable. It should be noted that these correlations are unsatisfactory estimates of the tests' reliability. Since the only group of applicants available for these "reliability" data was a group of rejected applicants sufficiently motivated to retake the examinations in an attempt to be certified, it is quite probable that some of these applicants may have deliberately performed the following: (1) revised their responses to the questions in the B.I., (2) changed their work rate on the M.A.T., (3) guessed more on the M.A.T. and M.C. tests (since only right items were scored on these tests, scores would tend to rise with increased guessing), (4) studied material for the A.I. tests. In addition, differences among cases as to the time interval between the original test and repeat test would result in varying amounts of "practice effect."[11] These contingencies tend to lower a test-retest correlation and to affect mean scores.

A considerable proportion of reexamined applicants did not wait six weeks after their original failure and hence were disqualified. These applicants were not certified even though the scores of some of them were above the cutting scores of all tests. This resulted in the differentiation of four groups of "repeaters" in both studies. These groups are defined as follows:

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[11] From Figure 2, page 36, it may be seen that 77% of the cases in Repeat Study A and 55% in Repeat Study B took the repeat tests less than 6 weeks after their original testing.

TABLE 28

INTERCORRELATIONS OF "ORIGINAL" AND "REPEAT" SCORES OF REEXAMINED APPLICANTS

			1. Original Scores				2. Repeat Scores			
		STUDY	B.I.	M.A.T.	M.C.	A.I.	B.I.	M.A.T.	M.C.	A.I.
1. Original Scores	B.I.	A	—	-.457	.001	.109	.525	-.353	-.025	.079
		B	—	-.447	-.007	.222	.603	-.375	.010	.152
	M.A.T.	A		—	.128	.168	-.269	.752	.117	.141
		B		—	.042	.105	-.273	.786	.106	.147
	M.C.	A			—	.287	.061	.175	.697	.237
		B			—	.259	.096	.128	.743	.296
	A.I.	A				—	.160	.219	.243	.751
		B				—	.300	.169	.251	.771
2. Repeat Scores	B.I.	A					—	-.210	.000	.192
		B					—	-.216	.100	.269
	M.A.T.	A						—	.243	.226
		B						—	.223	.252
	M.C.	A							—	.329
		B							—	.335
	A.I.	A								—
		B								—
	Mean	A	7.06	30.74	47.44	72.32	8.19	37.41	50.22	86.34
		B	7.54	31.03	47.33	72.50	8.44	37.93	50.21	86.69
	σ	A	2.56	9.85	7.30	28.71	2.51	10.68	7.02	30.39
		B	2.79	9.87	7.21	28.86	2.62	10.69	7.39	31.28
	N	A = 361								
		B = 1304								

Group 1 - Certified - applicants passing tests at least six weeks after original rejection and passing on repeat trials. Hereafter referred to as Certified Group.

Group 2 - Uncertified - applicants repeating tests at least six weeks after original rejection and still failing. Hereafter referred to as Uncertified Group.

Group 3 - "Disqualified Above" - applicants disqualified for repeating tests within 6 weeks interval of original rejection. Repeat scores of these applicants are all above the cutting scores of the tests. Hereafter referred to as the "Disqualified Above" Group.

Group 4 - "Disqualified Below" - applicants disqualified for repeating tests within 6 weeks interval of original rejection. At least one of the repeat scores of these applicants is below the cutting scores of the tests. Hereafter referred to as "Disqualified Below" Group

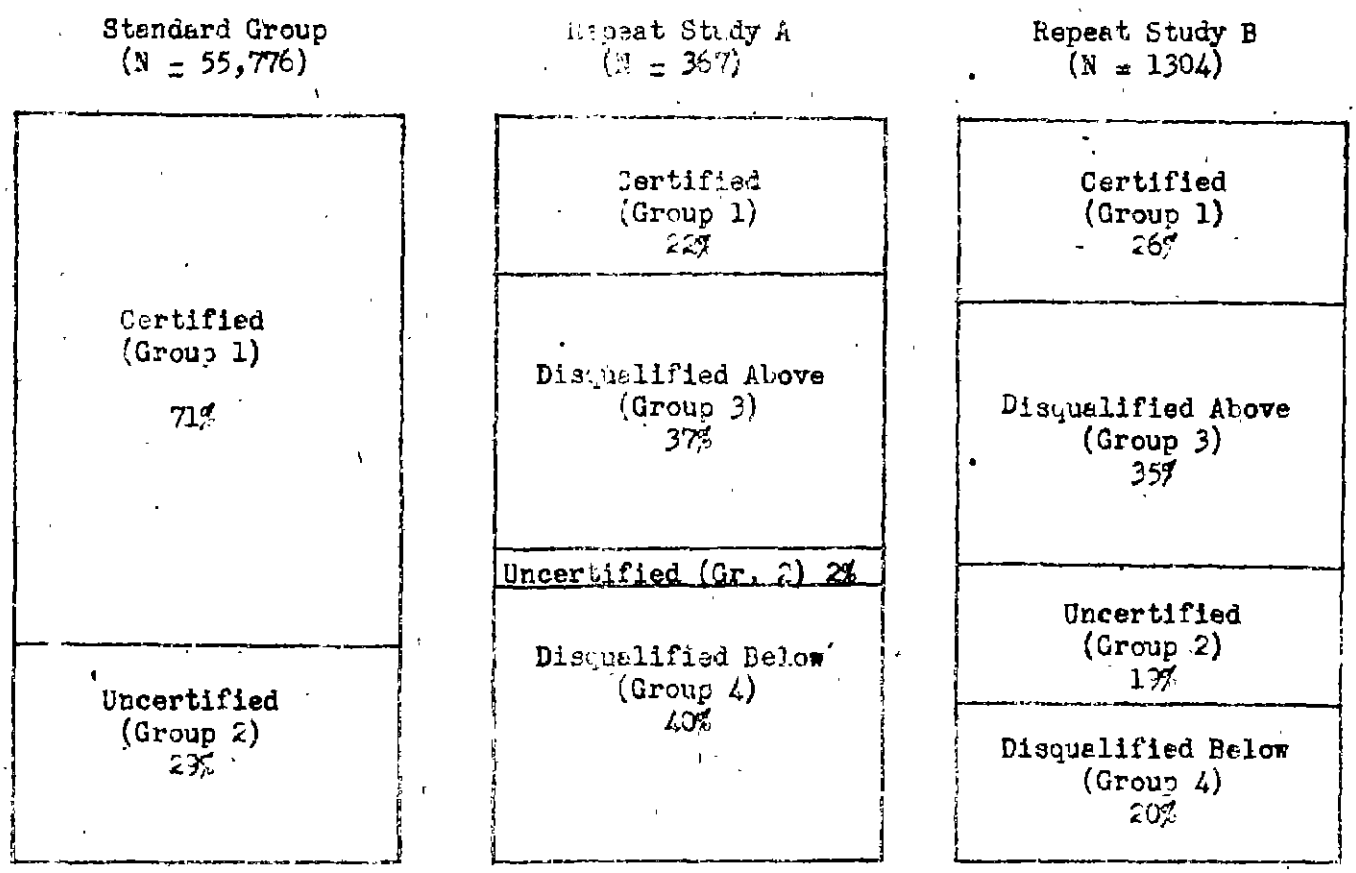

Figure 2

Comparison of Repeat Study and Standard Group

It is interesting to compare the proportion of the repeat cases falling in Groups 1 and 3 with the proportion of certified cases in the total population. This comparison is shown in Figure 2.

Figure 2 indicates that approximately 60 per cent of the cases in both "repeat" studies were in Groups 1 and 3, i.e., scored above the cutting score on their second B.I., M.A.T., and M. C. tests. This proportion is only 11 per cent less than the proportion of the total group certified, which is further evidence of the fact that the score pattern of the re-examined group tended to approximate the pattern of scores for the total group.

Summary. An analysis of the test scores of two groups of cases who were rejected on their first testing but who later retook the tests revealed that:

a. The mean test scores on the repeat testing increased significantly over those of the first testing. Repeat test scores on the M.C. and A.I. approximated the original scores of the total group.

b. The test-retest correlations of the four tests ranged from .53 (B.I.) to .79 (M.A.T.). These coefficients are probably underestimates of the reliability of the tests due to influences such as practice effects, coaching, changes in motivation, etc.

AN ANALYSIS OF THE SCREENING BATTERY IN RELATION TO PERFORMANCE IN PRIMARY FLIGHT TRAINING

1. Introduction. This analysis was undertaken in order to obtain evidence on the predictive value of the test battery by determining the relationship between the test scores of certified trainees and ultimate success in the primary flight training course. Criterion data were obtained on a sample of 4742 cases who were certified by the C.A.A.-National Testing Service and who took primary flight training on the July, 1942 War Training Service Program (the first program after the National Testing Service was begun). The criterion data were obtained from the records of the Civil Aeronautics Administration and consisted of flight grades assigned by the C.A.A. flight inspector during the final flight test, in the case of those who passed the course, and a statement as to the reason for failure, in the case of those who failed the course.

The reasons for failure were classified into nine groups: (1) inaptitude, (2) flight test failure, (3) maximum hours, (4) ground school failure, (5) illness or injury; (6) disciplinary reasons, (7) voluntary withdrawal, (8) action of medical section, and (9) other reasons; miscellaneous.

A group of 193 cases received no flight grades because they were removed from C.P.T. training at the "request of Army or Navy." These cases were eliminated from the analysis. Other types of cases eliminated from the final analysis were applicants for whom complete data were not available and

applicants indicating a preference for anything but primary training. In the case of applicants who took the examinations more than once, scores on the first testing were studied. The actual group studied included 4549 cases, of which 4257 were passers and 292 were failers.[12]

TABLE 29A

MEAN TEST SCORES AND FLIGHT HOURS OF FAILERS

Reason for Lack of Flight Grade	Number of Cases	Mean Hours Previous Training	Mean Test Scores B.I.	M.A.T.	M.C.	A.I.
1. Inaptitude	156	1.86	3.57	40.81	49.60	78.67
2. Flight Test Failure	26	3.15	3.69	39.35	50.65	77.42
3. Maximum Hours	6	11.33	3.33	33.17	49.00	75.67
4. Ground School Failure	4	5.50	2.75	32.25	48.00	73.00
5. Illness or Injury	43	2.46	3.90	39.21	51.71	76.10
6. Disciplinary Reasons	12	10.50	2.42	33.42	50.42	91.25
7. Voluntary Withdrawal	3	2.88	6.38	41.38	48.38	81.75
8. Action of Medical Section	6	3.33	8.67	43.17	51.83	80.00
9. Other Reasons; Miscellaneous	7	8.14	10.57	38.86	50.14	84.57
10. No Reason Given	19	1.47	3.47	40.53	51.58	87.42
11. Request of Army or Navy	193	4.64	3.15	41.63	52.05	86.45
Total N	435					

TABLE 29B

COMPARISON OF CRITERION CASES WITH CERTIFIED CASES OF PHASE I

	N	MEAN SCORES B.I.	M.A.T.	M.C.	A.I.	Flight Hours
Total Criterion Group (From Table B-61)	4549	3.13	41.66	52.27	92.32	6.61
Primary Certified, Phase I*	9287	3.02	41.89	52.02	84.12	2.79
All Certified, Phase I (From Table 5)	11888	3.40	41.97	52.32	97.51	16.28
Standard Group (From Table 5)	55776	8.73	39.22	50.64	36.60	9.04

*From Table 21 of a progress report on the C.A.A.-National Testing Service, Program I: June 20, 1942 - August 2, 1942 (copy in Committee files).

[12]The term "failer" is used for convenience to denote all cases having no flight grades except cases removed from C.P.T. training at the request of the Army or Navy. (Category 11 in Table 29A).

Mean test scores and hours of previous training for the separate categories of failure are presented in Table 29A. Table 29B presents the same information for the Total Criterion Group, along with comparable data for the Standard Group, for all certified cases in Phase I, and for those certified cases of Phase I who were classified as "primary" in an earlier analysis. The Total Criterion Group, in general, is more like the Phase I groups, as might be expected, since the Standard Group includes all four phases and phase differences were found to exist. In both A.I. and Flight Hours, however, the Total Criterion Group obtained higher mean scores than did the Phase I Primary Certified Group, the sub-group with which the Total Criterion Group might be expected to agree most closely. This may be attributed to two possible causes: (1) coordinators tended to put men with previous flight training into the July program and (2) some applicants classified as secondary by the National Testing Service actually took primary training in the W.T.S. program. The latter was possible since the National Testing Service arbitrarily classified as "secondary applicants" all those cases with more than 35 hours of previous flight training.

2. Plan of the Study. Three major groups of cases were analyzed in the study. These were:

a. Group A, consisting of Passers and Selected Failers (reasons 1, 2, 3, 4 above). N = 4449.

b. Group B, consisting of Passers and all Failers (reasons 1 to 10). N = 4549.

c. Group C, consisting of Passers and Selected Failers (reasons 1 to 4) from Flight Schools with Attrition. N = 3016. Attrition in a flight school is defined as the presence of at least one failer in the record card from which data were obtained.

Under each of Groups A, B, and C, cases reporting flight training prior to testing were treated separately from cases reporting no previous flight training.

In Groups A and B the passer cases are identical. Group A includes Failers for the reasons: (1) inaptitude, (2) flight test failure, (3) maximum hours, and (4) ground school failure. Although the tests in the screening battery were designed empirically to discriminate these types of failure, it is possible that failure for the remaining reasons (illness or injury, disciplinary reasons, voluntary withdrawal, action of medical section, miscellaneous) might be indirectly related to inaptitude. Group B therefore includes such Failers along with those of Group A.

Group C includes the Failers of Group A, while the Passers are restricted to those in whose flight school there was at least one failer. It was felt that the probability of discrimination by the tests would be increased by eliminating those schools where there were no failers; it was known, for example, that at least one of the flight schools gave an identical grade, viz., 80, to its entire quota of students.

In analyzing the relation of test scores to flight grades, two types of correlation coefficients were computed. These were: (1) biserial correlations of test scores with Pass-Fail, and (2) product-moment correlations, using the flight grades assigned to passers, and allotting a flight grade of zero to failers. Since this arbitrary procedure of assigning a zero grade to failers is questionable, product-moment correlations were also found for passers alone.

In the subsequent analysis a section will be devoted to each of the major groups (A, B, and C) mentioned above. Under each section will be found biserial and product-moment correlations for cases with previous hours, cases with no previous hours, and total cases; intercorrelations of tests and hours; and distributions of test and flight grades. Tables showing distributions of mean flight grades by schooling and age are also presented. A final Summary Table collates the various criterion correlations found in the study.

In interpreting the correlations in the following sections, it must be noted that all of the populations are curtailed at the lower score levels. In the general population which originally took the tests, approximately 30% failed one or more of the basic three tests in the battery (B.I., M.A.T., M.C.) and these cases were not to be certified for primary flight training. (A small proportion of cases below the cutting score on one test were "certified" if they had compensatory high ranking on the other two tests). These eliminated cases are specifically the ones designated by the tests as most likely to "washout" in flight training. As a result of this "screening" the apparent discriminatory efficiency of the tests may be lower for the cases in the present analysis than if all cases originally tested had been allowed to continue through flight training. Moreover, since the proportion of failers in the present sample is so small, the product-moment correlations obtained are substantially the same for the passers as for the total cases and what we are finding out is whether or not the tests predict a continuum of flight aptitude above their respective cutting scores.

A frequently-mentioned weakness of flight grades as criterion data is the variation in grading standards among different inspectors. As a preliminary check upon this point, distributions of grades were made from the record-cards of 100 flight schools. These record-cards were not a random selection, the sample being heavily weighted with schools in Texas.

The illustrative table (D-85) presents the distribution of flight grades from 10 cards which appeared consecutively in this sample of 100. These cards show that wide variations in grades were present. It will be noted that the grades for the Schools H, I, and J, show no overlap at all. Mean grades of men passing the flight test range from 72.37 to 92.40. There is also considerable variation in the range of grades within a particular school.

Analysis of the whole series of 100 cards reveals only one mean grade falling outside the above range - a mean grade of 71.30 for 10 men. In one school a single flight grade, 80, was given to all 15 men. In contrast,

another school showed a range of grades from 70 to 90.

The above data indicate the difficulties involved in the use of flight grades. A detailed analysis has not been made of these data because there is no assurance that grades in a single school were all assigned by a single inspector and also because there is no way of isolating variations in grading standards from variations in the teaching effectiveness of the various schools, or in the quality of the men entering the schools.

It is obvious, however, that any overlap in ability between men in schools H, I, and J, referred to above, is completely concealed in the flight grades which they received. Any significant variation in ability of the 15 men in the school receiving grades of 80 is also lost in the flight grades. Such variations in means and ranges of flight grades may have a limiting influence on the size of correlations between predictors and flight grades.

3. Group Consisting of Passers and Selected Failers (Group A). The group analyzed in this section is composed of all passers and failers for the reasons: (1) inaptitude, (2) flight test failure, (3) maximum hours, and (4) ground school failure. The number of passers is 4257 and the number of failers is 192. Of the passers, 1302 had previous flight training and of the failers, 33 had flight training prior to testing.

Table A-36 (See Appendix II[13]) summarizes the biserial correlations of the tests with Pass-Fail. It can be seen that the A.I. shows the highest correlation for the cases "with hours" (.293), while the M.C. shows the highest correlation for the cases "with no hours" (.211). For the cases "with hours" the number of previous flight hours is as good a predictor of Pass-Fail as any of the tests except the A.I. The correlations of all the tests except the M.C. are lower for the cases "with no hours." When both groups are thrown together into a total sample, the A.I. ranks first, and the M.C. second in order of Pass-Fail correlation.

Tables A-37 through A-45 present the intercorrelations among the tests for passers, failers, and total cases. Product-moment correlations of the tests with the flight grades [14] are also presented for passers and total cases. All of the criterion product-moment correlations are lower than the corresponding biserial correlations. This difference is characteristic throughout the study. The intercorrelations among the tests are substantially the same as those found in the Standard Groups in previous chapters.

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[13]The tables for the results of this study are gathered together in Appendix II, so that comparisons may be readily made between related results for the three basic groups.

[14]The criterion data sheets received from the C.A.A. offices had no grade entries for failers but merely listed the reasons for failing. For computing the biserial correlations of test scores with Pass-Fail, it is evident that no numerical flight grade had to be assigned to the failers. However, in computing product-moment correlations for total groups (passers

(continued on next page)

The chief differences in the present correlations are to be found in a comparison of Tables A-40, A-41, and A-42 (the intercorrelations of tests for passers) with Tables A-43, A-44 and A-45 (the intercorrelations of tests for failers) where some of the correlations for failers are quite different from those for passers.

Tables A-46 and A-47 give frequency distributions of flight grades, test scores, and flight hours for groups "with hours" and "with no hours." Comparison of these two tables reveals that the mean of the B.I. for cases with previous hours is 10.09; the mean for cases "with no hours" is 3.80. For the M.A.T., the mean of the cases "with hours" is 40.69, while the mean of those "with no hours" is 42.14. The mean of the M.C. for those "with hours" is 52.96 and for those "with no hours" it is 52.00. The mean of the A.I. cases "with hours" was 111.76, while that for those "with no hours" was 34.33. A large difference on this test was to be expected.

The various frequency distributions (A-49 through A-57) show that the means of the failers are always below the means of the passers and that at practically all levels of each test there is some discrimination between passers and failers. This can be seen by comparing the columns "% at and below interval" for passers and failers for each test.

With respect to cases with flight hours, it can be seen from Table A-57 that passers had a mean of 22.44 previous hours, while failers had a mean of 13.94 hours.

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14 (continued) and failers) with respect to test scores and flight grades it was necessary to assign some numerical grade to failers. This procedure was disturbing for two reasons: first, only a small proportion of the failers failed because of the flight test itself; and second, assignment of a flight grade to failers is of necessity arbitrary.

Three possible approaches to the problem were considered. Chiefly for ease of statistical work it was first assumed that failers had received a flight grade of zero. Correlations obtained under this assumption are to be found in Total Group matrices of test scores, hours, and flight grades. Since passer grades ranged only from 70 to 99, however, placing the flight grades of failers at zero distorts the scatter diagrams of test scores-flight grades markedly, and regression lines derived from such scatter diagrams would be very artificial.

Another approach to the problem with possible statistical justification was to determine the best estimate of a flight grade for failers on the assumption of a normal distribution of all flight grades. (The extent to which the distribution departs from normality is indicated in Table A-52.) There were 292 failers out of 4549 cases in the largest total group (Group B). Thus, failers comprised 6.42% of the cases, or $p = .9358$ and $q = .0642$.

From Kelley, T. L. (Statistical Method, New York: Macmillan, 1924,) it is known that in a unit normal distribution the mean deviation of the tail is

$$\text{M. Dev. of Tail} = \frac{q}{p}$$

or in this case where $q = .0642$

$$\text{M. Dev. of Tail} = 1.92 \text{ (in sigma units).}$$

[illegible] B. In this section the maximum [illegible] in this study is treated. All passers and all failers [illegible] are considered. The cases are [illegible] hours previous to [illegible] and those with no [illegible]. The number of Passers is the same as in Group A [illegible]. The number of failers is 29[illegible], of which 53 were cases with [illegible] cases with no previous hours.

As can be seen from a comparison [illegible] with Table A-36, the [illegible] correlations of the tests [illegible] about the same with the addition of the [illegible] to the failers of Group A. The greatest changes occur [illegible] for the cases with previous hours (from .29[illegible] in Group A to [illegible] in Group B); and for the M.C. for the cases with no previous hours (from [illegible] in Group A to .176 in Group B). When the total groups are considered the [illegible] correlations of the tests and flight hours with Pass-Fail appear to be quite stable. The largest change is for the M.C. for which the correlation is .197 for Group A and .170 for Group B.

The intercorrelations among the tests and flight hours and the product-moment correlations of tests and hours with flight grade also do not seem to change appreciably when these [illegible] other failers are added to Group A. Comparison of cases with hours, cases with no hours, and total cases can be made from inspection of Tables A-3[illegible] to A-39 with B-59 to B-61; comparable failer matrices are A-[illegible]3 to A-45 and B-62 to B-64.

[illegible]14 (continued) The best estimate of the M and σ of the total flight grades is obtained from the total passer group where M = 73.69 and σ = 4.55. Since the addition of the failers would lower the mean flight grade and increase the σ somewhat, it was arbitrarily assumed that in the total population comprised of passers and failers, the M and σ were 73 and 4.7 respectively. Using these values, the mean deviation of the tail of the distribution is approximately 9 and hence the "test estimate" of the flight grade of a failer is 69. Coefficients of correlation using this grade for failers are presented below, along with the corresponding correlations based on failer grades of zero (from Table B-61).

	Assumption of Flight Grade of Zero for Failers	Extrapolation of Normal Curve; Flight Grade of 69 for Failers
B.I.	.073	.116
M.A.I.	.063	.079
M.C.	.112	.146
A.I.	.131	.146
Hours	.077	.114

It can be seen that all of the correlations are higher where a failer grade of 69 is assumed rather than zero.

It might be expected that extrapolation of the normal curve, i.e., using the failer grade of 69 would give maximum correlations with predictors. An empirical check on this point was made by assigning an intermediate grade of

[illegible] to 3.69. Even for this [illegible] correlation of the tests to hours is the same as in Group [illegible] above higher means for the cases with previous hours of flight, one [illegible] remains about the same; and the M.A.T. has a lower mean [illegible] previous hours of flight than for the cases with no previous flight training. In general, it can probably be concluded from a comparison of Group A with Group B that the tests discriminate failers [illegible] other reasons (i.e., reasons 5-9 above) with approximately the same degree of success that they discriminate failers due to inadequate flight achievement.

Of the 4549 total cases studied in this analysis (all passers and all failers), it was found that 73 cases had not been certified in their first attempt at the screening battery. These cases had entered C.P.T. training either by passing the battery at a later date or by the failure of the coordinator to take note of the status of the candidate as issued by the National Testing Service.

Of these 73 cases, 10 had subsequently failed flight training (failing rate of 12.8%). Of the remaining 4471 cases who had been certified at their first testing 232 had subsequently failed Primary Flight training (failing rate of 6.3%).

The distribution of the Flight Grades of these 73 uncertified cases is as follows:

Flight Grade	N	Flight Grade	N	Flight Grade	N
87	1	81	1	75	12
86	0	80	13	74	3
85	2	79	2	73	3
84	0	78	7	72	8
83	4	77	2	71	2
82	3	76	3	70	2
				Failers	10

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14 (continued) 60 to failers. Using this grade correlations were again computed for the total group. Presented below are the resulting correlations:

	Assumption of Flight Grade of 60 for Failers
B.I.	.109
M.A.T.	.080
M.C.	.146
A.I.	.153
Hours	.109

It is obvious that using 69 as the flight grade for failers does not necessarily yield the maximum correlations. It seems that the maximum correlations would vary with the test considered, and with the population.

In the final selection of a grade for failers, it must be remembered that all such grades are very questionable. The very assumption that all failers would receive a single grade is unwarranted. Since the assumption that failers received flight grades of zero will obviously not overestimate the correlations of test score and flight grade, the product-moment correlations reported in this study were computed using zero for failers.

The mean of the 68 cases who had received flight grades of 70 or better (passers) is 77.07 and the σ of these cases is 4.00. For the "certified" 4139 cases who had received flight grades of 70 or better, the mean was 73.72 and the σ was 4.75. The critical ratio for this difference in means is 3.35 indicating that the probability that a difference as large or larger than this difference will arise by chance is about 4 out of 10,000. Although this difference is statistically reliable, it amounts to only 1.65 flight grade points and is of little practical significance.

5. Group Consisting of Passers and Selected Failers from Flight Schools with Attrition (Group C). Group C is composed of cases taken from flight schools exhibiting attrition. The only failers considered in this group are those who failed for the selected reasons (1-4) analyzed under Group A. Hence, the failers in Group C are identical with those in Group A. Throughout this study "attrition" is said to have occurred if there was at least one failer on the record sheet of the flight school from which the present data were obtained.

If the biserial correlations with Pass-Fail for Group C (Table C-70) are compared with those for Group A (Table A-36), it can be seen that the differences in correlation are quite small. However, all corresponding correlations are larger for Group C than for Group A with the exception of the B.I. for cases with previous flight hours. The largest differences occur for the A.I. (between .298 and .324 for cases with hours; .153 and .174 for cases with no hours, and .217 and .244 for the total groups). Thus, the elimination of cases from all-passer (non-attrition) schools tended to increase the correlation of tests and hours with Pass-Fail to a slight degree. The matrices of intercorrelations of test scores, hours, and flight scores for Group C likewise are comparable to those for Groups A and B. (Tables C-71 to C-75.)

The distributions of flight grades, test scores, and flight hours as presented in Tables C-76 to C-82 are similar to those for the other two groups. Test scores and hours are given for passers only because the failers have already been treated in Group A.

The analysis of Group C shows in general that the restriction of the sample to attrition groups tended to raise correlations with Pass-Fail to a very slight degree.

6. Distribution of Flight Grades by Schooling and Age. In Appendix II, Section 4 the relationships of amount of schooling and age of the candidate to ultimate flight grade in Primary Flight training are investigated. The cases are once again broken down into those with previous hours of flight and those with no flight hours previous to testing.

It can be seen from Table D-83 that the average flight grades of the college and high school cases are about the same, while those of the grade school applicants are slightly lower. Those having completed the freshman year of college or the sophomore year of secondary school have the highest mean flight grades. This holds true both for cases with hours and for cases without hours. In the college groups those with fewer years of college tend to obtain the higher flight grades, while in the high school groups the higher

flight grades are made by those having completed the second year or those having completed four or more years. In this table one can again see that the cases with no previous flight hours tend to make lower flight grades than those with previous hours of flight.

Table D-34 shows the relation of age to flight grade. Ages of candidates range from 16 to 37. For cases "with hours" and those "with no hours" the age of passers is lower than that of failers. Failers for the four selected reasons (1 through 4) are likewise older on the average than cases failed for reasons 5 through 10. It is fairly evident that there is little or no relationship between age level and flight score among Passers.

7. Summary. On a sample of 4549 cases, test battery performance was compared with criterion data on success in subsequent primary flight training. An analysis of biserial r's between test scores and pass-fail and Pearson r's between test scores and flight grades revealed that:

a. Each of the four tests showed positive but low correlation with success in flight training in spite of the fact that individuals with test scores below passing were not included in the experimental group.

b. The best test in the battery appears to be the A.I. with the M.C. next in predictive value. The superiority of the A.I., however, may be due to the fact that it was not used for screening purposes and hence its range of scores was not curtailed as much as in the case of the three tests.

c. When only certain selected failers or only cases from schools with some attrition are considered, the coefficients are not raised to any great degree over those obtained when all the failers are considered.

Additional findings were that cases with flight hours previous to enrollment appear to have a better chance of completing the course successfully than those with no previous flight hours and that the mean age of the failers was higher than that of the passers.

Summary Table D-35 presents the biserial and product-moment correlations of tests and hours with Flight Grades and Pass-Fail obtained in the three major groups of this study.

APPENDIX I

DISTRIBUTIONS OF TEST SCORES, PLACEBO SCORES, AND AGES OF SUBJECTS FOR THERAPY I, II, III, AND IV

TABLE 30

DISTRIBUTION OF INVENTORY OF PERSONAL DATA (B.I.) SCORES BY PHASE

	FREQUENCY Phase					% AT AND BELOW EACH LEVEL Phase				
Score	I	II	III	IV	Total	I	II	III	IV	Total
20	1	-	-	-	1	100	-	-	-	100
19	1	-	2	-	3	100	-	100	-	100
18	4	3	4	1	12	100	100	100	100	100
17	23	15	16	8	62	100	100	100	100	100
16	65	48	38	22	173	100	100	100	100	100
15	193	141	139	62	535	99	100	100	100	100
14	357	287	297	161	1102	98	99	99	99	99
13	663	651	627	310	2251	96	97	97	97	97
12	1115	1053	1076	627	3871	92	93	93	93	93
11	1683	1625	1631	989	5928	85	86	86	86	86
10	2163	2078	2204	1218	7663	75	75	76	74	75
9	2241	2132	2465	1360	8218	61	61	62	60	61
8	2341	2341	2369	1288	8339	47	47	46	44	47
7	2106	1940	1949	1092	7087	33	32	31	29	32
6	1532	1442	1446	647	5067	20	20	19	18	19
5	928	889	874	445	3136	11	10	9	8	10
4	489	422	405	184	1500	5	4	4	3	4
3	214	174	158	74	620	2	2	1	1	2
2	65	47	49	18	179	*	*	*	*	*
1	7	5	11	1	24	*	*	*	*	*
0	-	5	-	-	5	-	*	-	-	*
N	16,191	15,298	15,780	8,507	55,776					
Mean	8.76	8.75	8.78	8.89	8.78					
σ	2.64	2.56	2.51	2.43	2.55					

*Less than 0.5%

TABLE 31

DISTRIBUTION OF TEST OF MENTAL ABILITY M.A.T. SCORES BY PHASE

Score	FREQUENCY Phase I	II	III	IV	Total	% AT AND BELOW EACH LEVEL Phase I	II	III	IV	Total
79-80	-	2	1	1	4	-	100	100	100	100
75-78	10	3	10	-	23	100	100	100	100	100
71-74	25	26	20	18	89	100	100	100	100	100
67-70	59	61	60	48	228	100	100	100	100	100
63-66	117	114	149	78	458	99	99	99	99	99
59-62	247	220	256	143	866	99	99	98	98	99
55-58	545	523	530	376	1974	97	97	97	97	97
51-54	1068	1073	1175	613	3929	94	94	93	92	93
47-50	1685	1537	1722	1019	5963	87	87	86	85	86
43-46	2117	2124	2238	1215	7694	77	77	75	73	76
39-42	2739	2259	2375	1294	8308	64	63	61	59	62
35-38	2424	2331	2308	1715	8284	49	48	46	44	47
31-34	2021	1916	1947	1024	6898	34	33	31	29	32
27-30	1391	1347	1345	709	4741	22	20	19	17	20
23-26	1063	838	842	377	3120	13	11	10	9	11
19-22	584	476	442	244	1726	7	6	5	5	6
15-18	355	268	254	96	973	3	3	2	2	3
11-14	136	92	77	44	348	1	1	1	1	1
7-10	54	35	27	10	126	*	*	*	*	*
3-6	7	7	6	2	22	*	*	*	*	*
0-2	2	-	-	-	2	*	-	-	-	*
N	16,191	15,298	15,780	8,507	55,776					
Mean	38.60	39.07	39.50	40.14	39.22					
σ	10.69	10.33	10.30	10.29	10.43					

*Less than 0.5%

TABLE 32

DISTRIBUTION OF TEST OF MECHANICAL COMPREHENSION (M.C.) SCORES BY PHASE

	FREQUENCY					% AT AND BELOW EACH LEVEL				
	Phase					Phase				
Score	I	II	III	IV	Total	I	II	III	IV	Total
74-76	2	2	2	-	6	100	100	100	-	100
71-73	15	25	22	12	74	100	100	100	100	100
68-70	83	78	84	56	301	100	100	100	100	100
65-67	257	260	270	146	933	99	99	99	99	99
62-64	617	572	650	318	2157	98	98	98	97	98
59-61	1021	1042	1102	571	3736	94	94	93	94	94
56-58	1924	1907	1966	1068	6865	88	87	87	87	87
53-55	2365	2372	2380	1251	8368	76	75	74	74	75
50-52	2749	2575	2664	1389	9377	61	59	59	60	60
47-49	2488	2379	2371	1301	8539	44	42	42	43	43
44-46	1923	1745	1835	999	6502	29	27	27	28	28
41-43	1420	1215	1288	728	4651	17	15	15	16	16
38-40	706	634	633	392	2365	8	7	7	8	8
35-37	358	305	333	166	1162	4	3	3	3	3
32-34	162	123	124	72	481	2	1	1	1	1
29-31	57	46	42	25	170	1	*	*	*	*
26-28	33	9	10	7	59	*	*	*	*	*
23-25	10	6	3	4	23	*	*	*	*	*
20-22	1	1	1	-	3	*	*	*	*	*
17-19	-	1	-	2	3	-	*	-	*	*
14-16	-	1	-	-	1	-	*	-	-	*
N	16,191	15,298	15,780	8,507	55,776					
Mean	50.39	50.76	50.80	50.61	50.64					
σ	7.19	7.05	7.07	7.15	7.11					

TABLE 33

DISTRIBUTION OF TEST OF AVIATION INFORMATION (A.I.) SCORES BY PHASE

	FREQUENCY					% AT AND BELOW EACH LEVEL				
	Phase					Phase				
Score	I	II	III	IV	Total	I	II	III	IV	Total
190-199	2	2	1	2	7	100	100	100	100	100
180-189	7	5	3	5	20	100	100	100	100	100
170-179	73	39	41	17	170	100	100	100	100	100
160-169	219	150	139	78	586	99	100	100	100	100
150-159	438	335	285	159	1267	98	99	99	99	99
140-149	756	523	556	256	2083	95	97	97	97	96
130-139	914	713	680	326	2633	90	93	94	94	93
120-129	1052	939	859	529	3379	85	88	89	90	88
110-119	1209	1166	1213	640	4228	78	82	84	84	82
100-109	1362	1341	1443	747	4893	71	75	76	76	74
90-99	1509	1571	1622	865	5567	62	66	67	68	65
80-89	1527	1657	1681	929	5774	53	56	57	58	55
70-79	1610	1741	1835	1045	6231	44	45	46	47	45
60-69	1622	1634	1831	999	6075	34	34	34	34	34
50-59	1423	1424	1478	819	5144	24	23	23	23	23
40-49	1114	1009	1068	590	3781	15	14	13	13	14
30-39	726	630	592	322	2270	8	7	7	6	7
20-29	369	282	312	149	1112	4	3	3	2	3
10-19	170	114	119	32	415	1	1	1	*	1
0-9	68	38	22	8	136	*	*	*	*	*
N	16,191	15,298	15,780	8,507	55,776					
Mean	88.26	86.50	85.62	85.46	86.60					
σ	35.94	34.34	32.66	32.03	34.03					

*Less than 0.5%

TABLE 34

DISTRIBUTION OF FLIGHT HOURS BY PHASE

Flight Hours	FREQUENCY Phase I	II	III	IV	Total	% AT AND BELOW EACH LEVEL Phase I	II	III	IV
95 and over	911	420	187	73	1591	100	100	100	100
90-94	53	48	20	3	124	94	97	99	99
85-89	61	36	21	10	128	94	97	99	99
80-84	92	56	29	18	195	94	97	99	99
75-79	91	61	48	12	212	93	96	98	99
70-74	80	50	40	16	186	92	96	98	99
65-69	92	58	34	10	194	92	96	98	98
60-64	142	101	68	33	344	91	95	98	98
55-59	102	95	51	20	268	91	95	97	98
50-54	180	180	119	46	525	90	94	97	98
45-49	300	135	102	27	564	89	92	96	97
40-44	443	247	133	63	886	87	90	95	97
35-39	637	236	175	55	1103	84	90	95	96
30-34	166	155	132	64	517	80	89	93	95
25-29	199	166	137	60	562	79	88	93	95
20-24	287	229	194	93	803	78	87	92	94
15-19	292	246	246	127	911	76	85	91	93
10-14	461	390	407	172	1430	75	84	89	91
5-9	661	624	685	297	2267	72	81	86	89
0-4	10,941	11,765	12,952	7,308	42,966	68	77	82	86
N	16,191	15,298	15,780	8,507	55,776				
Mean	14.73	9.14	5.69	4.26	9.04				
σ	27.69	21.99	16.54	14.22	21.90				

TABLE 35

DISTRIBUTION OF AGE BY PHASE

Age	FREQUENCY Phase I	II	III	IV	Total	% AT AND BELOW EACH LEVEL Phase I	II	III	IV	Total
37 and over	46	32	26	8	112	100	100	100	100	100
36	391	381	312	121	1205	100	100	100	100	100
35	439	407	377	151	1374	97	97	98	98	98
34	519	540	433	248	1740	95	95	95	97	95
33	588	575	568	290	2021	91	91	93	94	92
32	628	717	656	376	2377	88	87	89	90	88
31	774	807	794	357	2732	84	83	85	86	84
30	826	888	916	446	3076	79	77	80	82	79
29	1075	1058	1073	549	3755	74	71	74	77	74
28	1145	1224	1307	589	4265	67	65	67	70	67
27	1112	1140	1254	627	4133	60	57	59	63	59
26	533	577	585	239	1934	53	49	51	56	52
25	554	511	498	209	1772	50	45	47	53	48
24	552	515	559	214	1840	47	42	44	51	45
23	577	465	485	209	1736	43	39	41	48	42
22	771	762	721	285	2539	40	35	37	46	39
21	2215	1644	968	314	5141	35	30	33	42	34
20	1800	1781	2030	758	6369	21	20	27	38	25
19	1032	797	1350	1416	4595	10	8	14	30	14
18	600	408	792	1059	2859	4	3	5	13	5
17 and under	14	20	31	42	107	*	*	*	*	*
No age indicated	-	49	45	-	94					
N	16,191	15,298	15,780	8,507	55,776					
Mean	25.61	26.06	25.61	24.67	25.59					
σ	5.22	5.16	5.22	5.54	5.27					

*Less than 0.5%

APPENDIX II

LIST OF TABLES FOR CRITERION STUDY

APPENDIX II

LIST OF TABLES FOR CRITERION STUDY

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[1] Intercorrelations in general are of test scores, flight grades, and hours.

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SECTION 1

Group Consisting of Passers and Selected Failers

(Group A)

TABLE A-36

GROUP CONSISTING OF PASSERS AND SELECTED FAILERS

Biserial Correlations of Test Scores and Hours with Pass-Fail

Cases with Previous Flight Hours

	M_P	M_F	σ_T	N_P	N_F	Bis-r
1. B.I.	10.1029	9.4545	2.3540	1302	33	.115
2. M.A.T.	40.7619	37.8788	8.6514	1302	33	.140
3. M.C.	52.9985	51.4848	6.2295	1302	33	.103
4. A.I.	112.2604	92.1515	28.1010	1302	33	.298
5. Flight Hours	22.4401	13.9394	24.7173	1302	33	.143

Cases with No Previous Flight Hours

	M_P	M_F	σ_T	N_P	N_F	Bis-r
1. B.I.	8.8166	8.4277	2.1029	2955	159	.086
2. M.A.T.	42.2139	40.6730	8.3976	2955	159	.085
3. M.C.	52.1469	49.3208	6.1803	2955	159	.211
4. A.I.	84.8152	75.4088	28.3323	2955	159	.153

Total Group

	M_P	M_F	σ_T	N_P	N_F	Bis-r
1. B.I.	9.1839	8.6042	2.2600	4257	192	.120
2. M.A.T.	41.7017	40.1927	8.5004	4257	192	.084
3. M.C.	52.8902	49.6927	6.2107	4257	192	.197
4. A.I.	92.5653	78.2864	30.9324	4257	192	.217
5. Flight Hours	6.6705	2.3958	16.9445	4257	192	.119

TABLE A-37

GROUP CONSISTING OF PASSERS AND SELECTED FAILERS

Cases with Flight Hours Previous to Enrollment
Intercorrelations

	1	2	3	4	5	6
1. B.I.	-	-.026	.160	.293	.214	.068
2. M.A.T.		-	.270	.320	-.068	.067
3. M.C.			-	.379	.017	.083
4. A.I.				-	.273	.143
5. Flight Hours					-	.079
6. Flight Grade*						-
M	10.09	40.69	52.96	111.76	22.23	77.44
σ	2.35	8.65	6.23	28.10	24.72	13.13

N = 1335

*Failures were allotted a flight grade of zero.

TABLE A-38

Cases with No Flight Hours
Intercorrelations

	1	2	3	4	5
1. B.I.	-	-.055	.149	.255	.060
2. M.A.T.		-	.255	.307	.059
3. M.C.			-	.390	.123
4. A.I.				-	.085
5. Flight Grade*					-
M	8.80	42.14	52.00	84.33	74.38
σ	2.10	8.40	6.18	28.33	17.80

N = 3114

*Failures were allotted a flight grade of zero.

TABLE A-39

Total Group Intercorrelations

	1	2	3	4	5	6
1. B.I.	-	-.064	.165	.342	.255	.081
2. M.A.T.		-	.253	.252	-.077	.053
3. M.C.			-	.381	.050	.118
4. A.I.				-	.353	.123
5. Flight Hours					-	.078
6. Flight Grade*						-
M	9.18	41.70	52.29	92.56	6.67	75.30
σ	2.26	8.50	6.21	30.93	16.94	16.60

N = 4449

*Failures were allotted a flight grade of zero.

TABLE A-40

GROUP CONSISTING OF PASSERS AND SELECTED FAILERS

Passers with Flight Hours Previous to Enrollment
Intercorrelations

	1	2	3	4	5	6
1. B.I.	-	-.022	.157	.292	.210	.083
2. M.A.T.		-	.266	.317	-.069	.053
3. M.C.			-	.379	.014	.139
4. A.I.				-	.267	.113
5. Flight Hours					-	.085
6. Flight Grade						-
M	10.10	30.76	53.00	112.26	22.44	79.40
σ	2.36	8.63	6.23	28.01	24.87	4.58

N = 1302

TABLE A-41

Passers with No Previous Flight Hours
Intercorrelations

	1	2	3	4	5
1. B.I.	-	-.058	.143	.249	.085
2. M.A.T.		-	.252	.312	.083
3. M.C.			-	.389	.109
4. A.I.				-	.059
5. Flight Grade					-
M	8.82	42.21	52.15	84.82	78.38
σ	2.11	8.43	6.14	28.24	4.50

N = 2955

TABLE A-42

Total Group of Passers
Intercorrelations

	1	2	3	4	5	6
1. B.I.	-	-.065	.159	.338	.254	.108
2. M.A.T.		-	.250	.253	-.078	.065
3. M.C.			-	.378	.045	.124
4. A.I.				-	.353	.111
5. Flight Hours					-	.100
6. Flight Grade						-
M	9.21	41.77	52.41	93.21	6.86	78.69
σ	2.27	8.52	6.18	30.88	17.21	4.55

N = 4257

GROUP CONSISTING OF PASSED AND SECOND PAIRS

TABLE A-43

Failers with Flight Hours Previous to Enrollment Intercorrelations

	1	2	3	4	5
1. B.I.	-	-.312	.227	.190	.394
2. M.A.T.		-	.401	.302	-.345
3. M.C.			-	.307	.049
4. A.I.				-	.391
5. Flight Hours					-
M	9.45	37.88	51.48	92.15	13.94
σ	2.00	8.83	6.11	24.58	15.84
N = 33					

TABLE A-44

Failers with No Previous Flight Hours Intercorrelations

	1	2	3	4
1 B.I.	-	-.021	.200	.332
2.M.A.T.		-	.273	.167
3.M.C.			-	.326
4.A.I.				-
M	8.43	40.67	49.32	75.41
σ	1.96	7.60	6.28	28.53
N = 159				

TABLE A-45

Total Group of Failers Intercorrelations

	1	2	3	4	5
1. B.I.	-	-.103	.224	.339	.248
2. M.A.T.		-	.274	.153	-.136
3. M.C.			-	.341	.096
4. A.I.				-	.247
5. Flight Hours					-
M	8.60	40.19	49.69	78.29	2.40
σ	2.00	7.90	6.31	28.60	8.41
N = 192					

GROUP CONSISTING OF PASSERS AND SELECTED FAILERS

TABLE A-46

Cases with Previous Hours of Flight Training

FREQUENCY DISTRIBUTION OF FLIGHT GRADES WITH CORRESPONDING MEANS OF TEST SCORES AND HOURS

Flight Grade	N	% at and Below Interval	B.I. Mean	M.A.T. Mean	M.C. Mean	A.I. Mean	Hours Mean
90 and Above	13	100	10.4	42.8	54.5	126.4	32.6
89	4	99	9.5	39.5	54.5	108.0	48.5
88	23	99	11.0	43.6	54.6	117.8	30.3
87	21	97	9.6	41.3	54.4	121.0	20.0
86	29	96	10.4	42.4	55.1	118.1	18.8
85	142	93	10.8	41.7	54.3	118.4	26.8
84	57	83	10.3	41.9	54.6	116.3	17.8
83	56	79	10.1	39.5	53.7	111.4	29.3
82	20	74	10.5	39.9	53.0	112.8	23.3
81	25	68	10.0	40.8	53.4	113.4	24.8
80	281	66	9.9	40.5	52.8	111.1	23.7
79	26	45	9.7	39.0	52.0	106.2	25.0
78	127	43	9.9	41.7	52.9	110.0	17.3
77	25	33	10.1	39.1	52.4	115.7	18.9
76	52	31	9.5	39.6	52.5	112.1	20.3
75	144	27	10.0	41.1	53.0	111.0	22.5
74	42	17	9.8	40.0	51.3	108.2	15.8
73	35	14	10.0	40.3	50.5	104.1	21.3
72	66	11	10.2	38.6	51.1	107.0	19.4
71	9	6	10.8	42.1	56.8	110.8	22.8
70	37	5	9.8	41.6	51.2	109.4	17.8
FAILERS	33	3	9.5	37.9	51.5	92.2	13.9
Total Mean			10.09	40.69	52.96	111.76	22.23
σ			2.35	8.65	6.23	28.10	24.72
N = 1335							

GROUP CONSISTING OF PASSERS AND SELECTED FAILERS

TABLE A-47

Cases with No Previous Flight Hours

FREQUENCY DISTRIBUTION OF FLIGHT GRADES WITH CORRESPONDING MEANS OF TEST SCORES

Flight Grade	N	% at and Below Interval	B.I. Mean	M.A.T. Mean	M.C. Mean	A.I. Mean
90 and Above	36	100	9.6	43.3	51.9	84.8
89	6	99	9.3	41.7	51.2	89.3
88	19	99	9.1	45.6	52.5	93.8
87	30	98	9.2	44.6	55.1	88.6
86	29	97	9.3	42.9	53.2	93.2
85	203	96	9.1	43.1	53.2	83.4
84	77	90	9.1	45.3	53.9	92.4
83	107	87	8.6	42.8	52.8	83.8
82	196	84	9.1	42.8	52.9	88.7
81	76	77	8.9	43.1	52.5	89.6
80	615	75	8.8	41.9	52.6	84.7
79	87	55	9.3	43.3	52.2	86.4
78	310	52	8.6	42.8	51.9	85.4
77	84	42	8.5	43.3	51.3	86.9
76	131	40	8.9	41.1	52.1	85.5
75	390	36	8.7	41.2	51.2	83.5
74	106	23	8.7	40.8	51.8	81.8
73	108	20	8.4	42.4	51.1	80.2
72	172	16	8.7	41.2	51.3	82.4
71	39	11	8.4	41.2	50.6	86.0
70	134	7	8.6	41.3	51.5	80.2
FAILERS	159	5	8.4	40.7	49.3	75.4
Total Mean			8.80	42.14	52.00	84.33
σ			2.10	8.40	6.18	28.33

N = 3114

GROUP CONSISTING OF PASSERS AND SELECTED FAILERS

TABLE A-48

Total Cases

FREQUENCY DISTRIBUTION OF FLIGHT GRADES WITH CORRESPONDING MEANS OF TEST SCORES

Flight Grade	N	% at and Below Interval	B.I. Mean	M.A.T. Mean	M.C. Mean	A.I. Mean
90 and Above	49	100	9.8	43.2	52.6	[illegible]
89	8	99	9.4	41.1	52.0	[illegible]
88	42	99	10.1	44.5	[illegible]	[illegible]
87	51	98	9.4	[illegible]	[illegible]	[illegible]
86	58	97	9.9	42.7	[illegible]	[illegible]
85	345	95	9.8	42.9	53.7	[illegible]
84	134	88	9.6	43.8	[illegible]	[illegible]
83	163	85	9.1	41.7	53.1	[illegible]
82	286	81	9.6	41.9	53.6	[illegible]
81	101	74	9.2	42.5	[illegible]	[illegible]
80	896	72	9.2	41.5	52.6	[illegible]
79	113	52	9.4	42.3	[illegible]	[illegible]
78	437	50	9.0	42.5	[illegible]	[illegible]
77	109	40	8.9	42.4	51.5	[illegible]
76	163	37	9.1	40.7	[illegible]	[illegible]
75	534	33	9.0	41.2	51.7	[illegible]
74	148	21	9.0	40.6	[illegible]	[illegible]
73	143	18	8.8	41.9	50.9	[illegible]
72	238	15	9.1	40.5	51.2	[illegible]
71	48	9	8.9	41.4	51.8	[illegible]
70	171	8	8.8	41.4	51.4	[illegible]
FAILERS	192	4	8.6	40.2	49.7	78.3
Total Mean			9.13	41.70	52.29	92.56
σ			2.26	8.50	6.21	30.93
N = 4449						

GROUP CONSISTING OF PASSERS AND SELECTED FAILERS

TABLE A-49

Cases with Flight Hours Previous to Enrollment

FREQUENCY DISTRIBUTION OF B.I. SCORES

B.I. Score	N_P	% at and Below Interval	N_F	% at and Below Interval
20	1	100	-	-
19	0	100	-	-
18	1	100	-	-
17	6	100	-	-
16	11	99	-	-
15	31	98	-	-
14	53	96	1	100
13	105	93	3	97
12	157	85	0	88
11	201	73	3	88
10	218	57	10	79
9	187	41	6	48
8	151	26	6	30
7	116	15	1	12
6	53	6	2	9
5	7	1	1	3
4	3	*	-	-
3	1	*	-	-
TOTAL	1302		33	

	Passers	Failers
M	10.10	9.45
σ	2.36	2.00

TABLE A-50

Cases with No Previous Flight Hours

FREQUENCY DISTRIBUTION OF B.I. SCORES

B.I. Score	N_P	% at and Below Interval	N_F	% at and Below Interval
20	-	-	-	-
19	-	-	-	-
18	-	-	-	-
17	-	-	-	-
16	-	-	-	-
15	19	100	1	100
14	44	99	1	99
13	72	98	3	99
12	176	95	5	97
11	327	89	13	94
10	453	78	25	86
9	475	63	20	70
8	509	47	33	57
7	465	30	32	36
6	319	14	21	16
5	82	3	5	3
4	9	*	-	-
3	5	*	-	-
TOTAL	2955		159	

	Passers	Failers
M	8.82	8.43
σ	2.17	1.96

GROUP CONSISTING OF PASSERS AND SELECTED FAILERS

TABLE A-51

Cases with Flight Hours Previous to Enrollment

FREQUENCY DISTRIBUTION OF M.A.T. SCORES

M.A.T. Score	N_P	% at and Below Interval	N_F	% at and Below Interval
75-78	1	100	-	-
71-74	1	100	-	-
67-70	1	100	-	-
63-66	12	100	1	100
59-62	22	99	0	97
55-58	48	97	0	97
51-54	94	93	0	97
47-50	140	86	5	97
43-46	196	75	3	82
39-42	219	60	5	73
35-38	243	44	8	58
31-34	198	25	5	33
27-30	83	10	3	18
23-26	34	3	1	9
19-22	8	1	2	6
15-18	2	*	-	-
TOTAL	1302		33	

	Passers	Failers
M	40.76	37.88
σ	8.63	8.83

TABLE A-52

Cases with No Previous Flight Hours

FREQUENCY DISTRIBUTION OF M.A.T. SCORES

M.A.T. Score	N_P	% at and Below Interval	N_F	% at and Below Interval
75-78	2	100	-	-
71-74	4	100	-	-
67-70	11	100	-	-
63-66	29	99	1	100
59-62	71	98	3	99
55-58	113	96	5	97
51-54	254	92	9	94
47-50	362	84	12	87
43-46	496	72	23	79
39-42	539	55	37	67
35-38	522	36	35	43
31-34	384	19	27	21
27-30	122	6	6	6
23-26	33	1	1	1
19-22	6	*	-	-
15-18	4	*	-	-
11-14	1	*	-	-
TOTAL	2955		159	

	Passers	Failers
M	42.21	40.67
σ	8.43	7.60

GROUP CONSISTING OF PASSERS AND SELECTED FAILERS

TABLE A-53

Cases with Flight Hours Previous to Enrollment

FREQUENCY DISTRIBUTION OF M.C. SCORES

M.C. Score	N_P	% at and Below Interval	N_F	% at and Below Interval
74-76	1	100	-	-
71-73	4	100	-	-
68-70	11	100	1	100
65-67	31	99	0	97
62-64	74	96	0	97
59-61	122	91	3	97
56-58	196	81	6	88
53-55	236	66	2	70
50-52	242	48	10	64
47-49	167	30	5	33
44-46	141	17	1	18
41-43	67	6	5	15
38-40	9	1	-	-
35-37	1	*	-	-
TOTAL	1302		33	

	Passers	Failers
M	53.00	51.48
σ	6.23	6.11

TABLE A-54

Cases with No Previous Flight Hours

FREQUENCY DISTRIBUTION OF MC. SCORES

M.C. Score	N_P	% at and Below Interval	N_F	% at and Below Interval
74-76	1	100	-	-
71-73	9	100	-	-
68-70	17	100	1	100
65-67	64	99	2	99
62-64	134	97	3	98
59-61	214	93	5	96
56-58	451	85	18	93
53-55	501	70	21	82
50-52	569	53	24	69
47-49	441	34	25	53
44-46	311	19	31	38
41-43	218	9	25	18
38-40	30	1	2	3
35-37	1	*	0	1
32-34	3	*	2	1
TOTAL	2955		159	

	Passers	Failers
M	52.15	49.32
σ	6.14	6.28

GROUP CONSISTING OF PASSERS AND SELECTED FAILERS

TABLE A-55

Cases with Flight Hours Previous to Enrollment

FREQUENCY DISTRIBUTION OF A.I. SCORES

A.I. Scores	N_P	% at and Below Interval	N_F	% at and Below Interval
170-179	13	100	-	-
160-169	29	99	-	-
150-159	70	97	-	-
140-149	133	91	1	100
130-139	134	81	2	97
120-129	158	70	3	91
110-119	167	58	2	82
100-109	158	45	6	76
90-99	159	33	3	58
80-89	105	21	4	48
70-79	81	13	5	36
60-69	48	7	4	21
50-59	24	3	3	9
40-49	15	1	-	-
30-39	2	*	-	-
TOTAL	1302		33	
	Passers		Failers	
M	112.26		92.15	
σ	28.01		24.58	

TABLE A-56

Cases with No Previous Flight Hours

FREQUENCY DISTRIBUTION OF A.I. SCORES

A.I. Scores	N_P	% at and Below Interval	N_F	% at and Below Interval
180-189	1	100	-	-
170-179	1	100	-	-
160-169	8	100	-	-
150-159	27	100	-	-
140-149	71	99	4	100
130-139	100	96	2	97
120-129	159	93	7	96
110-119	214	88	6	92
100-109	292	80	13	88
90-99	366	70	17	80
80-89	367	58	15	69
70-79	363	46	25	60
60-69	409	33	24	44
50-59	298	20	15	29
40-49	163	9	14	19
30-39	86	4	9	11
20-29	26	1	7	5
10-19	3	*	1	1
0-9	1	*	-	-
TOTAL	2955		159	
	Passers		Failers	
M	84.82		75.41	
σ	28.24		28.53	

GROUP CONSISTING OF PASSERS AND SELECTED FAILERS

TABLE A-57

Cases with Flight Hours Previous to Enrollment

FREQUENCY DISTRIBUTION OF FLIGHT HOURS

Flight Hours	N_P	% at and Below Interval	N_F	% at and Below Interval	Mean Flight Grade for Passers
90 and Over	66	100	-	-	80.0
80-89	11	95	-	-	79.9
70-79	25	94	1	100	80.4
60-69	25	92	1	97	80.4
50-59	50	90	0	94	80.2
40-49	61	86	0	94	80.6
30-39	104	82	1	94	79.2
20-29	169	74	3	91	79.9
10-19	268	61	12	82	79.2
0-9	523	40	15	45	79.0
TOTAL	1302		33		

	Passers	Failers
M	22.44	13.94
σ	24.87	15.84

SECTION 2

Group Consisting of Passers

and All Failers

(Group B)

Biserial Correlations of Test Scores and Hours with Pass-Fail

Cases with Pre-Cruise Flight Hours

	M_P	M_F	σ_t	N_P	N_F	Bis-r
1. B.I.	10.1029	9.5066	2.3758	1302	53	.101
2. M.A.T.	40.1619	37.7736	8.6556	1302	53	.153
3. M.C.	52.9965	51.4340	6.2193	1302	53	.112
4. A.I.	118.2604	97.3962	28.1610	1302	53	.234
5. Flight Hrs.	22.4401	15.2542	21.7715	1302	53	.111

Cases with No Pre-Cruise Flight Hours

	M_P	M_F	σ_t	N_P	N_F	Bis-r
1. B.I.	7.8156	5.5607	2.1070	2955	239	.060
2. M.A.T.	42.2139	41.5439	8.4004	2955	239	.097
3. M.C.	52.1469	49.9205	6.1398	2955	239	.176
4. A.I.	84.6152	73.3305	28.3729	2955	239	.164

Total Group

	M_P	M_F	σ_t	N_P	N_F	Bis-r
1. B.I.	9.2100	8.7432	2.2601	4257	292	.099
2. M.A.T.	41.7698	40.0411	8.5041	4257	292	.097
3. M.C.	52.4073	50.1952	6.2113	4257	292	.170
4. A.I.	93.2093	73.3357	30.9986	4257	292	.214
5. Flight Hrs.	6.8633	2.9521	16.8777	4257	292	.111

GROUP CONSISTING OF PASSERS AND ALL FAILERS

TABLE B-59

Cases with Previous Flight Hours
Intercorrelations

	1	2	3	4	5	6
1. B.I.	-	-.026	.159	.289	.209	.065
2. M.A.T.		-	.269	.320	-.069	.079
3. M.C.			-	.375	.015	.085
4. A.I.				-	.274	.129
5. Flight Hours					-	.070
6. Flight Grade*						-
M	10.08	40.65	52.94	111.68	22.20	76.29
σ	2.35	8.66	6.22	28.16	24.70	16.03
N = 1355						

TABLE B-60

Cases with No Previous Flight Hours
Intercorrelations

	1	2	3	4	5
1. B.I.	-	-.055	.151	.254	.048
2. M.A.T.		-	.257	.312	.068
3. M.C.			-	.391	.114
4. A.I.				-	.098
5. Flight Grade					-
M	8.80	42.09	51.93	84.11	72.51
σ	2.11	8.40	6.21	28.38	21.07
N = 3194					

TABLE B-61

Total Group
Intercorrelations

	1	2	3	4	5	6
1. B.I.	-	-.064	.266	.339	.251	.073
2. M.A.T.		-	.253	.255	.077	.063
3. M.C.			-	.380	.049	.112
4. A.I.				-	.353	.131
5. Flight Hours					-	.077
6. Flight Grade						-
M	9.18	41.66	52.87	92.32	56.61	73.64
σ	2.25	8.50	6.23	31.00	16.86	17.78
N = 4549						

*Failers were allocated a flight score of zero.

GROUP CONSISTING OF PASSERS AND ALL FAILERS

TABLE B-62

Failures with Previous Flight Hours Intercorrelations

	1	2	3	4	5
1. B.I.	-	-.239	.148	.130	.087
2. M.A.T.		-	.262	.289	-.178
3. M.C.			-	.211	-.028
4. A.I.				-	.395
5. Flight Hours					-
M	9.57	37.77	51.43	97.40	16.26
σ	2.04	8.77	5.80	28.25	19.44

N = 53

TABLE B-63

Failures with No Previous Flight Hours Intercorrelations

	1	2	3	4
1. B.I.	-	-.038	.214	.296
2. M.A.T.		-	.269	.267
3. M.C.			-	.340
4. A.I.				-
M	8.56	40.54	49.92	75.33
σ	2.07	7.85	6.36	28.66

N = 239

TABLE B-64

Total Failure Group Intercorrelations

	1	2	3	4	5
1. B.I.	-	-.039	.216	.304	.140
2. M.A.T.		-	.255	.220	-.145
3. M.C.			-	.330	.047
4. A.I.				-	.299
5. Flight Hours					-
M	8.74	40.04	50.20	79.34	2.95
σ	2.10	8.09	6.29	29.82	10.39

N = 292

GROUP CONSISTING OF PASSERS AND ALL FAILERS

TABLE B-65

Distribution of B.I. Scores for Additional Failers

B.I. SCORE	With Hours	With No Hours	Total
14	-	2	2
13	1	2	3
12	4	6	10
11	3	11	14
10	5	10	15
9	1	11	12
8	3	10	13
7	0	18	18
6	3	7	10
5	-	1	1
4	-	1	1
3	-	1	1
TOTAL	20	80	100
M	9.75	8.83	9.01

TABLE B-66

Distribution of M.A.T. Scores for Additional Failers

M.A.T. Score	With Hours	With No Hours	Total
59-62	-	1	1
55-58	1	3	4
51-54	0	4	4
47-50	3	13	16
43-46	2	9	11
39-42	2	17	19
35-38	3	12	15
31-34	5	11	16
27-30	2	6	8
23-26	2	3	5
19-22	-	1	1
TOTAL	20	80	100
M	37.60	40.29	39.75

[illegible]

TABLE B-67

Distribution of M.C. Scores for Additional Failers

M.C. Scores	With Hours	With No Hours	Total
68-70	[illegible]	[illegible]	[illegible]
65-67	[illegible]	4	4
62-64	[illegible]	1	1
59-61	2	6	8
56-58	3	6	9
53-55	5	14	19
50-52	3	15	18
47-49	1	16	17
44-46	4	10	14
41-43	1	6	8
38-40	[illegible]	2	2
TOTAL	20	80	100
M	54.35	51.11	51.36

TABLE B-68

Distribution of A.I. Scores for Additional Failers

A.I. Scores	With Hours	With No Hours	Total
170-9	[illegible]	1	1
160-9	[illegible]	1	1
150-9	2	0	2
140-9	0	1	1
130-9	3	1	4
120-9	1	2	3
110-9	5	2	7
100-9	3	4	7
90-9	2	11	13
80-9	0	9	9
70-9	0	10	10
60-9	0	8	8
50-9	3	15	18
40-9	0	8	8
30-9	1	7	8
TOTAL	20	80	100
M	106.05	75.18	81.35

GROUP CONSISTING OF PASSERS AND ALL FAILERS

TABLE B-69

Distributions of Hours for Additional Failers

Hours	
90 or More	1
80-9	0
70-9	0
60-9	0
50-9	2
40-9	0
30-9	2
20-9	2
10-9	4
0-9	9
TOTAL	20
M	20.10

SECTION 3

Group Consisting of Passers and Selected Failers from Flight Schools with Attrition

(Group C)

GROUP CONSISTING OF PASSERS AND SELECTED FAILERS
FROM FLIGHT SCHOOLS WITH ATTRITION

TABLE C-70

Biserial Correlations of Test Scores and Hours with Pass-Fail

Cases with Previous Flight Hours

	M_P	M_F	σ_T	N_P	N_F	Bis-r
1. B.I.	10.0557	9.4545	2.4067	897	33	.109
2. M.A.T.	41.0011	37.8788	8.6753	897	33	.158
3. M.C.	52.9777	51.4848	6.2140	897	33	.105
4. A.I.	112.8350	92.1515	27.9341	897	33	.324
5. Flight Hrs.	22.4649	13.9394	24.5861	897	33	.152

Cases with No Previous Flight Hours

	M_P	M_F	σ_T	N_P	N_F	Bis-r
1. B.I.	8.8163	8.4277	2.1289	1927	159	.090
2. M.A.T.	42.1484	40.6730	8.3175	1927	159	.087
3. M.C.	52.1982	49.3208	6.1633	1927	159	.229
4. A.I.	85.5714	75.4088	28.7594	1927	159	.174

Total Group

	M_P	M_F	σ_T	N_P	N_F	Bis-r
1. B.I.	9.2100	8.6042	2.2919	2824	192	.126
2. M.A.T.	41.7840	40.1927	8.4460	2824	192	.090
3. M.C.	52.4458	49.6927	6.1961	2824	192	.212
4. A.I.	94.2312	78.2864	71.1747	2824	192	.244
5. Flight Hrs.	7.1356	2.3956	17.0630	2824	192	.133

[illegible]

TABLE C-71

Passers with Previous Hours

	1	2	3	4	5	6
1. B.I.	-	-.052	.165	.315	.221	.080
2. M.A.T.		-	.253	.277	-.113	.063
3. M.C.			-	.379	.043	.128
4. A.I.				-	.295	.114
5. Previous Hours					-	.082
6. Flight Grade						-
M	10.06	41.0	58.98	112.84	22.46	79.04
σ	2.42	8.65	6.21	27.78	24.80	4.62
N = 897						

TABLE C-72

Total Groups with Previous Hours

	1	2	3	4	5	6
1. B.I.	-	-.046	.168	.315	.226	.068
2. M.A.T.		-	.260	.284	-.109	.082
3. M.C.			-	.379	.046	.080
4. A.I.				-	.302	.164
5. Previous Hours					-	.085
6. Flight Grade*						-
M	10.03	40.83	58.92	112.10	22.16	76.24
σ	2.41	8.63	6.21	27.93	24.59	15.31
N = 930						

TABLE C-73

Passers with No Previous Hours

	1	2	3	4	5
1. B.I.	-	-.087	.122	.248	.098
2. M.A.T.		-	.249	.297	.104
3. M.C.			-	.395	.099
4. A.I.				-	.085
5. Flight Grade					-
M	8.82	42.15	52.20	85.57	77.86
σ	2.14	8.36	6.10	28.64	4.48
N = 1927					

*For Total Groups, Failures were allotted a flight grade of zero.

GROUP CONSISTING OF PASSERS AND SELECTED FAILERS
FROM FLIGHT SCHOOLS WITH ATTRITION

TABLE C-74

Total Cases with No Previous Hours

	1	2	3	4	5
1. B.I.	-	-.080	.132	.257	.067
2. M.A.T.		-	.254	.290	.067
3. M.C.			-	.397	.141
4. A.I.				-	.108
5. Flight Grade*					-
M	8.79	42.04	51.98	84.80	71.93
σ	2.13	8.32	6.17	28.76	21.11
N = 2086					

TABLE C-75

Total Group

	1	2	3	4	5	6
1. B.I.	-	-.085	.157	.345	.256	.089
2. M.A.T.		-	.250	.238	-.087	.063
3. M.C.			-	.385	.063	.130
4. A.I.				-	.363	.151
5. Flight Hours					-	.090
6. Flight Grade*						-
M	9.17	41.68	52.27	93.22	6.83	73.26
σ	2.29	8.45	6.20	31.17	17.06	19.60
N = 3016						

*Failers were allotted a flight grade of zero.

GROUP CONSISTING OF PASSERS AND SELECTED FAILERS FROM FLIGHT SCHOOLS WITH ATTRITION

TABLE C-76

Cases with Previous Hours of Flight Training

FREQUENCY DISTRIBUTION OF FLIGHT GRADES WITH CORRESPONDING MEANS OF TEST SCORES AND HOURS

Flight Grade	N	% at and Below Interval	B.I. Mean	M.A.T. Mean	M.C. Mean	A.I. Mean	Hours
90 and Above	7	100	10.1	41.6	51.0	135.0	28.0
88	16	99	11.2	44.4	54.8	119.1	27.2
87	13	98	9.5	40.9	53.7	111.2	16.8
86	16	96	10.4	43.9	54.1	122.3	19.8
85	90	94	11.0	42.6	54.5	118.1	27.9
84	40	85	9.9	41.3	54.9	116.7	17.4
83	32	80	9.8	39.1	52.8	109.4	34.4
82	58	77	10.5	40.5	53.4	115.2	23.1
81	15	71	9.9	43.1	53.3	121.4	25.1
80	198	69	9.8	40.5	52.9	111.6	23.3
79	17	48	9.5	39.5	52.9	106.3	23.7
78	86	46	9.9	42.3	52.7	113.2	19.7
77	15	37	10.3	38.6	52.7	117.9	22.3
76	40	35	9.9	39.8	52.5	115.2	19.4
75	108	31	9.7	41.2	53.1	109.5	22.5
74	29	19	9.9	41.7	52.2	113.8	16.2
73	25	16	9.9	38.2	51.0	105.6	21.0
72	52	13	10.3	38.8	50.7	107.5	19.6
71	6	8	10.3	43.8	56.2	109.8	28.3
70	34	7	9.9	41.6	51.3	106.8	15.8
FAILERS	33	4	9.5	37.9	51.5	92.2	13.9
Total Mean			10.03	40.89	52.92	112.10	22.16
σ			2.41	8.68	6.21	27.93	24.59
N = 930							

GROUP CONSISTING OF PASSERS AND SELECTED FAILERS FROM FLIGHT SCHOOLS WITH ATTRITION

TABLE C-77

Cases with No Previous Flight Hours

FREQUENCY DISTRIBUTION OF FLIGHT GRADES WITH CORRESPONDING MEANS OF TEST SCORES

Flight Grade	N	% at and Below Interval	B.I. Mean	M.A.T. Mean	M.C. Mean	A.I. Mean
90 and Above	16	100	10.1	45.1	51.6	94.2
89	2	99	10.0	45.0	54.5	106.0
88	10	99	9.4	43.8	50.0	94.9
87	18	99	9.4	45.3	55.6	95.4
86	13	98	9.6	43.5	52.9	94.8
85	112	97	9.3	43.3	53.3	87.0
84	46	92	9.2	46.0	54.0	94.3
83	63	90	8.4	44.4	52.1	84.1
82	120	87	9.2	42.6	52.6	88.4
81	42	81	8.8	42.2	52.7	91.4
80	386	79	8.9	41.8	52.8	85.1
79	56	60	9.3	42.5	52.0	84.9
78	206	58	8.7	43.3	52.1	86.1
77	50	48	8.7	43.9	52.1	91.8
76	81	45	8.7	40.5	52.0	87.1
75	272	41	8.7	40.6	51.5	84.0
74	70	28	8.7	40.9	52.6	84.1
73	84	25	8.3	42.6	51.4	79.1
72	137	21	8.8	41.2	51.1	83.5
71	26	14	8.4	40.8	51.0	90.1
70	117	13	8.6	41.3	51.4	79.6
FAILERS	159	8	8.4	40.7	49.3	75.4
Total Mean			8.79	42.04	51.98	84.80
σ			2.13	8.32	6.17	28.76
N = 2086						

GROUP CONSISTING OF PASSERS AND SELECTED FAILERS
FROM FLIGHT SCHOOLS WITH ATTRITION

TABLE C-73

Distributions of B.I. Scores for Passers

B.I. Score	With Hours N	% at and Below Interval	With No Hours N	% at and Below Interval
20	1	100	-	-
19	0	100	-	-
18	1	100	-	-
17	5	100	-	-
16	9	99	-	-
15	23	98	12	100
14	27	96	33	99
13	70	93	50	98
12	103	85	119	95
11	131	73	208	89
10	150	59	297	78
9	141	42	294	63
8	92	26	312	47
7	87	16	317	31
6	49	6	214	14
5	4	1	56	3
4	3	*	6	*
3	1	*	2	*
TOTAL	897		2085	
M	10.06		8.79	
σ	2.42		2.13	

GROUP CONSISTING OF PASSERS AND SELECTED FAILERS
FROM FLIGHT SCHOOLS WITH ATTRITION

TABLE C-79

Distributions of M.A.T. Scores for Passers

M.A.T. Score	With Hours N	% at and Below Interval	With No Hours N	% at and Below Interval
75-78	1	100	-	-
71-74	1	100	4	100
67-70	1	100	6	100
63-66	7	100	12	99
59-62	16	99	53	99
55-58	35	97	74	96
51-54	68	93	174	92
47-50	102	86	224	83
43-46	133	74	327	72
39-42	153	59	344	55
35-38	170	42	337	37
31-34	128	23	253	19
27-30	52	9	92	6
23-26	21	3	24	1
19-22	7	1	2	*
15-18	2	*	1	*
TOTAL	897		2086	
M	41.00		42.04	
σ	8.65		8.32	

GROUP CONSISTING OF [illegible] SELECTED TRAINEES
FROM FLIGHT SCHOOLS WITH ATTRITION

TABLE C-6a

Distribution of M.C. Scores for Passers

M.C. Score	With Hours N	% at and Below Interval	With No Hours N	% at and Below Interval
74-76	1	100	-	-
71-73	3	100	-	-
68-70	8	100	12	100
65-67	23	99	47	99
62-64	50	96	76	97
59-61	72	91	150	93
56-58	142	82	288	85
53-55	163	67	333	70
50-52	173	48	367	53
47-49	113	29	300	34
44-46	95	17	193	18
41-43	47	6	143	8
38-40	7	1	17	1
35-37	-	-	0	*
32-34	-	-	1	*
TOTAL	897		2086	
M	52.98		51.98	
σ	6.21		6.17	

GROUP CONSISTING OF PASSERS AND SELECTED FAILERS
FROM FLIGHT SCHOOLS WITH ATTRITION

TABLE C-81

Distributions of A.I. Scores for Passers

A.I. Scores	With Hours N	% at and Below Interval	With No Hours N	% at and Below Interval
180-189	-	-	1	100
170-179	8	100	1	100
160-169	19	99	6	100
150-159	52	97	19	100
140-149	97	91	51	99
130-139	100	80	73	96
120-129	107	69	114	93
110-119	111	57	150	87
100-109	114	45	195	79
90-99	105	32	228	69
80-89	65	21	243	57
70-79	58	13	222	44
60-69	35	7	264	33
50-59	14	3	192	19
40-49	11	1	107	9
30-39	1	*	45	4
20-29	-	-	19	1
10-19	-	-	2	*
0-9	-	-	1	*
TOTAL	897		2086	
M	112.84		84.80	
σ	27.78		28.76	

GROUP CONSISTING OF PASSERS AND SELECTED FAILERS
FROM FLIGHT SCHOOLS WITH ATTRITION

TABLE C-82

Distributions of Flight Hours for Passers

Hours	N	% at and Below Interval
90 and Over	44	100
80-89	9	95
70-79	20	94
60-69	14	92
50-59	36	90
40-49	42	86
30-39	68	82
20-29	122	74
10-19	182	60
0-9	360	40
TOTAL	897	
M	22.46	
σ	24.79	

SECTION 4

Distribution of Flight Grades

by Schooling and Age

TABLE D-83

Distributions of Flight Grades by Schooling*

COLLEGE

Years Completed	Cases with Previous Hours				Cases with No Previous Hours			
	M.F.G.	N_P	N_F	N_{AF}	M.F.G.	N_P	N_F	N_{AF}
4 or More	78.20	109	4	4	77.55	287	32	10
3	79.04	55	1	0	77.46	151	5	2
2	79.46	162	2	3	78.60	385	21	5
1	80.01	171	7	1	78.78	473	21	13
TOTAL	79.33	497	14	8	78.30	1296	79	30

HIGH SCHOOL

Years Completed	Cases with Previous Hours				Cases with No Previous Hours			
	M.F.G.	N_P	N_F	N_{AF}	M.F.G.	N_P	N_F	N_{AF}
4 or More	79.51	613	12	8	78.52	1375	63	38
3	78.91	91	3	0	78.02	142	9	4
2	80.08	61	2	2	78.98	65	3	2
1	78.28	25	1	0	76.94	31	3	2
TOTAL	79.44	790	18	10	78.46	1613	78	46

GRADE SCHOOL

Years Completed	Cases with Previous Hours				Cases with No Previous Hours			
	M.F.G.	N_P	N_F	N_{AF}	M.F.G.	N_P	N_F	N_{AF}
7 or 8	78.67	12	1	2	77.17	30	2	4

No Grade indicated = 19

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*LEGEND: M.F.G. is the Mean Flight Grade for Passers in the category.

N_P = Number Passers

N_F = Number Failers for four major reasons:

1. Inaptitude
2. Flight test failure
3. Maximum hours
4. Ground School hours

N_{AF} = Number Additional Failers for other reasons (5 to 10)

TABLE D-84

Distributions of Mean Flight Grades by Age of Applicants*

Age	Cases with Previous Hours				Cases with No Previous Hours			
	M.F.G.	N_P	N_F	N_{AF}	M.F.G.	N_P	N_F	N_{AF}
37	83.5	2	-	-	-	-	-	-
36	79.9	22	-	2	76.6	44	6	2
35	77.5	38	2	0	76.8	52	1	3
34	79.6	56	2	0	77.5	55	7	2
33	79.2	59	6	1	77.4	71	7	3
32	78.3	66	2	1	78.5	82	7	4
31	79.0	75	2	2	77.8	109	14	0
30	79.0	70	4	2	78.1	134	13	1
29	79.3	125	3	3	78.1	176	13	6
28	79.1	123	3	1	77.9	226	10	2
27	79.7	115	4	0	78.4	205	11	5
26	78.9	39	1	1	78.6	78	5	1
25	80.3	41	1	0	78.5	97	1	7
24	80.9	48	1	0	78.5	90	2	4
23	79.9	47	0	0	78.8	101	4	0
22	79.2	51	0	2	78.1	129	5	3
21	80.2	131	1	2	78.6	541	24	14
20	79.1	109	1	3	78.8	425	11	8
19	79.7	59	-	-	78.7	207	11	3
18	79.4	30	-	-	79.3	131	6	2
17	-	-	-	-	82.0	1	-	-
16	-	-	-	-	80.0	2	-	-
AGES								
M		26.61	29.61	27.30		24.55	26.35	25.13
σ		4.97	3.69	5.26		4.90	5.31	4.91
N		1302	33	20		2953	159	80

No Age indicated = 2

*LEGEND: M.F.G. is Mean Flight Grade for Passers
N_P = Number Passers
N_F = Number Failers for four major reasons (1 to 4)
N_{AF} = Number Additional Failers for other reasons (5 to 10)

TABLE D-65

Distribution of Flight Grades Taken from Record Cards for Ten Consecutive Flight Schools in Texas

Flight Grade	Number of Men Receiving Grade									
	School A	School B	School C	School D	School E	School F	School G	School H	School I	School J
96										1
95										1
94										
93										
92										1
91										
90					1					
89			1							
88										
87										
86		1								
85				1	4	1			11	
84			3							
83		1	1	1					2	
82		1	2	2		1	1			
81									1	
80		1	4	11	3	4	5	1		
79		1	1					3		
78		3		2			3	2		
77		1						1		
76	1	1		2				3		
75	1	1				3	2	2		
74	3	2	1							
73	3					1				
72	3			1				1		
71	7	3								
70	1	1					3			
Failures	1		0	0	0	0	1	0	0	0
TOTALS	20	16	19	82	8	10	15	13	14	10
Mean Grade of Passers	72.37	77.40	81.52	79.60	83.75	78.60	76.86	76.92	84.43	92.4
Range of Passing Scores	7	17	16	14	11	13	13	9	5	

SUMMARY TABLE D-66

Correlations of Test Scores and Hours with Flight Grades and Biserial Correlations with Pass-Fail

A. Group Consisting of Passers and Selected Failers

	Cases Reporting Flight Training Prior to Testing		Cases Reporting No Flight Training Prior to Testing		Total Cases	
	Bis-r	r	Bis-r	r	Bis-r	r
.I.	.115	.068	.086	.060*	.120	.081*
.A.T.	.140	.067	.085	.059*	.084	.053*
.C.	.103	.083*	.211	.123*	.197	.118*
A.I.	.298	.143*	.153	.085*	.217	.123*
Hours	.143	.079	-	-	.119	.078*
		N = 1335		N = 3114		N = 4449

B. Group Consisting of Passers and All Failers

	Cases Reporting Flight Training Prior to Testing		Cases Reporting No Flight Training Prior to Testing		Total Cases	
	Bis-r	r	Bis-r	r	Bis-r	r
.I.	.101	.065	.060	.048	.099	.073*
.A.T.	.153	.079	.097	.068*	.097	.063*
.C.	.112	.085*	.176	.114*	.170	.112*
.I.	.234	.129*	.164	.098*	.214	.131*
	.111	.070	-	-	.111	.077*
		N = 1355		N = 3194		N = 4549

C. Group Consisting of Passers and Selected Failers from Flight Schools with Attrition

	Cases Reporting Flight Training Prior to Testing		Cases Reporting No Flight Training Prior to Testing		Total Cases	
	Bis-r	r	Bis-r	r	Bis-r	r
.I.	.109	.068	.090	.067	.126	.089*
A.T.	.158	.082	.087	.067	.090	.063*
.C.	.105	.080	.229	.141	.212	.130*
.I.	.324	.164*	.174	.108	.244	.151*
	.152	.085	-	-	.133	.090*
		N = 930		N = 2086		N = 3016

1 Pearsonian r's followed by an asterisk are statistically significant in that are equal to or above the minimum r which would yield a "t" of 3.0 on the ...ion of true correlation equal to zero. For a description of this test of ...ficance see: Lindquist, E. F. Statistical analysis in educational research ... York: Houghton Mifflin Co., 1940, pp. 210-211.