TECHNICAL RESEARCH NOTE 112

Validation of the Army Fixed-Wing Aptitude Battery Against Success in Army Flight Training

HUMAN FACTORS RESEARCH BRANCH

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VALIDATION OF THE ARMY FIXED-WING APTITUDE BATTERY AGAINST SUCCESS IN ARMY FLIGHT TRAINING

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Submitted by

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BRIEF

VALIDATION OF THE ARMY FIXED-WING APTITUDE BATTERY AGAINST SUCCESS IN ARMY FLIGHT TRAINING

Requirement:

Research to improve selection of trainees for the Army Aviation Fixed-Wing Training Program was requested by DCSPER. A battery of tests prepared by HFRB and made operational in 1956 required further validation against actual trainee performance.

Procedure:

The Army Fixed-Wing Aptitude Battery (AFWAB), based on the Air Force Officer Qualification Test used in the selection of Aviation Cadets, was administered to 1109 men in classes entering the Army Aviation Fixed-Wing Training Program at Camp Gary during 1957. AFWAB scores were analyzed in relation both to failure to complete flight training and to failure by reason of flying deficiency.

Findings:

The AFWAB is moderately effective in selecting trainees for Army Fixed-Wing flight training. Scores based on unit weights of component tests were as effective as scores obtained by more complicated statistical weighting.

Utilization of Findings:

The presently used unit weighting of AFWAB subtest scores is satisfactory. Operational use of AFWAB for this program will be aided by tables provided for establishing cutting scores on the battery in terms of trainee requirements and allowable attrition rate for a given selection period.

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CONTENTS

TABLES

FIGURES

VALIDATION OF THE ARMY FIXED-WING APTITUDE BATTERY AGAINST SUCCESS IN ARMY FLIGHT TRAINING

The Army uses fixed-wing aircraft for specified activities within the combat zone, and necessarily in training for those activities. Flight activities are involved in the coordination and control of Army forces in the field through such services as communications, observations, visual and photographic reconnaissance, fire adjustment aids, and topographical survey. Airlift of personnel and materiel and medical evacuation are major functions. All Army flight activities are closely coordinated with the actions of surface forces.

Army fixed-wing pilots must hold currently valid Army aviation or senior aviation designations and be physically qualified both for flying duty and for operating fixed-wing aircraft. When the Army began to develop its own aircraft organization, selection of personnel to be trained as Army pilots posed no special problem, since many officers and warrant officers trained as pilots in the U. S. Army Air Corps had remained with the Army as aviators after the formation of the Air Force. However, it soon became necessary to train men who had had no previous flying experience. Approved applicants for Army flight training were sent to Camp Gary Air Force Base near San Marcos, Texas where training was initially given by the Air Force. Since 1955, however, the Army has trained its own fixed-wing aircraft personnel.

Air Force personnel in charge of training early noted a high rate of attrition among Army pilot trainees. A screening procedure was obviously needed to reduce loss of duty time, travel expense, and cost of flight training for applicants who were eliminated during the course. Research to develop appropriate instruments and procedures was initiated in September 1955 by the Human Factors Research Branch at the request of DCSPER.

The current Army Aviation Fixed-Wing Training Program for commissioned officers is provided in two consecutive courses: (1) The Army Primary Flight Training Course, and (2) the Army Aviation Tactics Course. Officers are designated Army Aviators after completing the second course. Virtually all attrition from the training program occurs during the primary training phase.

The Army Fixed-Wing Aptitude Battery (AFWAB) was prepared on the basis of the Air Force Officer Qualification Test used in the selection of Air Force Aviation cadets. Operational use of the AFWAB in selecting men for Army Flight Training was authorized in 1956. Concurrently, research was begun to evaluate the new battery against training criteria. In view of the fact that little attrition occurs beyond primary flight training, success in the Primary Flight Training Course was selected as the criterion.

The AFOQT had proved useful in selecting students for the Air Force primary pilot training course. A tabular presentation of percentage

eliminated during training for each stanine--based on AFOQT composite scores--was included in a report by Christal and Krumboltz (1957). The analysis was conducted on 1178 AFROTC graduates of the year 1954 who had been tested with the Air Force battery in 1953. Conversion of results to a biserial validity coefficient yielded an r of .39. In view of the result, moderately high correlation between the AFWAB--a slightly modified version of the AFOQT--and success in the Army Primary Flight Training Program was expected.

PURPOSE OF PRESENT STUDY

The purpose of the present study was to determine the validity of the battery in relation to success in the Army Primary Flight Training Program (FTP), and to provide information which could be used to establish cutting scores appropriate to the Army's training requirements for a given year. The effect of weighting the tests by a multiple correlation procedure was also studied.

PROCEDURE

Variables

Criterion Variables:

1. Pass-Fail FTP: A dichotomous variable consisting of students who successfully completed the course versus students who failed for any reason. Students who for any reason did not complete the course were considered failures.

2. Pass-Fail Flying Deficiency: A dichotomous variable consisting of students who successfully completed primary flight training at Camp Gary versus student whose failure was due to flying deficiency. All of the students who are included under this criterion are also in the pass-fail total criterion group. However, the pass-fail flying deficiency criterion excludes those students who failed for reasons other than flying deficiency.

Predictor Variables: The predictors consisted of the five tests of the Army Fixed-Wing Aptitude Battery and the AFWAB composite scores:

1. Background Inventory, DA Form 6234. Consists of 30 five-choice items dealing with the individual's family, education, hobbies, and employment background. The time limit is ten minutes. Scoring formula is rights only.

2. Aeronautical Information Test, DA Form 6235. Consists of 30 five-choice items dealing with the individual's general and technical knowledge of aeronautical information. The time limit is twenty minutes. Scoring formula is rights minus 1/4 wrongs.

3. Mechanical Principles Test, DA Form 6236. Consists of 30 five-choice items dealing with the ability of the individual to understand general mechanical principles. The time limit is thirty minutes. Scoring formula is right minus 1/4 wrongs.

4. Aircraft Orientation Test, DA Form 6237. Consists of 28 five-choice picture items dealing with the ability of the individual to visualize the relationship between an airplane and the territory over which it flies. The test differs from its prototype in the Air Force Officer Qualifying Test in that

silhouettes of planes are used instead of photographs. The time limit is ten minutes. Scoring formula is rights minus 1/4 wrongs.

5. Flight Visualization Test, DA Form 6238. Consists of 28 five-choice picture items dealing with the ability of the individual to visualize airplane maneuvers. In this test also, silhouettes were substituted for the photographs used in the Air Force test. The time limit is thirty minutes. Scoring formula is rights minus 1/4 wrongs.

6. AFWAB Composite Score. Obtained by summing the final scores on each of the five subtests. The final score on each subtest consists of the raw score less any correction for guessing.

Population and Samples

The battery is used to select trainees from among officers and officer candidates who volunteer for training in the use of fixed-wing aircraft. The AFWAB was administered experimentally to each entering class at Camp Gary, beginning in August 1957 and continuing for one year. The sample for the main analysis consisted of 1109 entering students. For 809 men in this sample, the experimental administration of the AFWAB was the first--and only--occasion on which they took the tests. The remainder had previously been tested with the AFWAB, some operationally as applicants for Army Flight Training (N = 191), some as applicants for ROTC flight training (N = 40), and some (N = 69) both as ROTC students and later in the Army as applicants for flight training. In the case of men who had been tested with AFWAB more than once, scores from the initial testing were used in the analysis. Total AFWAB scores and scores on component tests were evaluated for effectiveness in discriminating between successful and unsuccessful FTP trainees. Criterion information was based on reports submitted by training officials to the Human Factors Research Branch as each class completed training.

Applicants who had previously taken the AFWAB and who were rejected for flight training constituted a second sample (N = 770) used only to test the representativeness of the acceptee sample in terms of AFWAB scores.

RESULTS

AFWAB Validity

In the total sample, using passing or failing the Flight Training Program as the criterion measure, the AFWAB composite score yielded a validity coefficient of .41 (Table 1). Each of the component tests had significant correlation with the pass-fail criterion. Validity coefficients ranged from .15 for the Background Inventory Test to .34 for the Aeronautical Information Test. Validity coefficients are biserial r's

converted from point-biserial coefficients. Comparison of the sample (consisting of acceptees) with the rejectee sample indicated that correction for restriction in range on AFOQT was not necessary.[1]

Table 1

VALIDITY COEFFICIENTS[a] AND INTER-r's OF AFWAB COMPONENT TESTS AND COMPOSITE SCORE FOR THE FTP PASS-FAIL TRAINING SAMPLE (N = 1109)

	Variable	Mean	S.D.	Intercorrelation Coefficients						
1.	Background Inventory	9.79	3.56	1						
2.	Aeronautical Information	9.63	6.08	.27	2					
3.	Mechanical Principles	15.46	5.74	.22	.34	3				
4.	Aircraft Orientation	10.74	6.10	.14	.21	.40	4			
5.	Flight Visualization	10.92	8.01	.18	.22	.53	.50	5		
6.	AFWAB Composite Score	56.55	20.18	.43	.59	.76	.70	.80	6	
7.	Criterion (Pass-Fail Training)	.73	.44	.15	.34	.27	.28	.30	.41	7[a]

[a]Biserial validity coefficients.

In the subsample consisting of men who had been administered the AFWAB only once (N = 809), and that experimentally at Camp Gary, a validity coefficient of .42 was obtained against the pass-fail training criterion. Against pass-fail by reason of flying deficiency (N = 740) the coefficient was .32 (Tables A-1 and A-2 of Appendix). The difference in the validity values for the two criteria cannot, however, with assurance be attributed to AFWAB prediction of attrition in the non-flying

[1]The AFWAB standard deviation for the sample of acceptees was 20.2, for the rejectees, 21.0. The means for acceptees and rejectees were 56.55 and 56.46 respectively. The differences were not significant.

phase of the training program. Some men withdraw from the Flight Training Program in anticipation of failure for flying deficiency. In that case, attrition is not officially ascribed to flying deficiency although such failure may be the basic reason for withdrawal.

Selective Efficiency of the AFWAB

The selective efficiency of the battery is illustrated in Figure 1. The sample of FTP trainees was ranked on AFWAB total score and divided into quarters. A substantial increase in the percentage of students successfully completing the course was observed in moving from the bottom to the top quarter. See also Table A-3 of the Appendix.

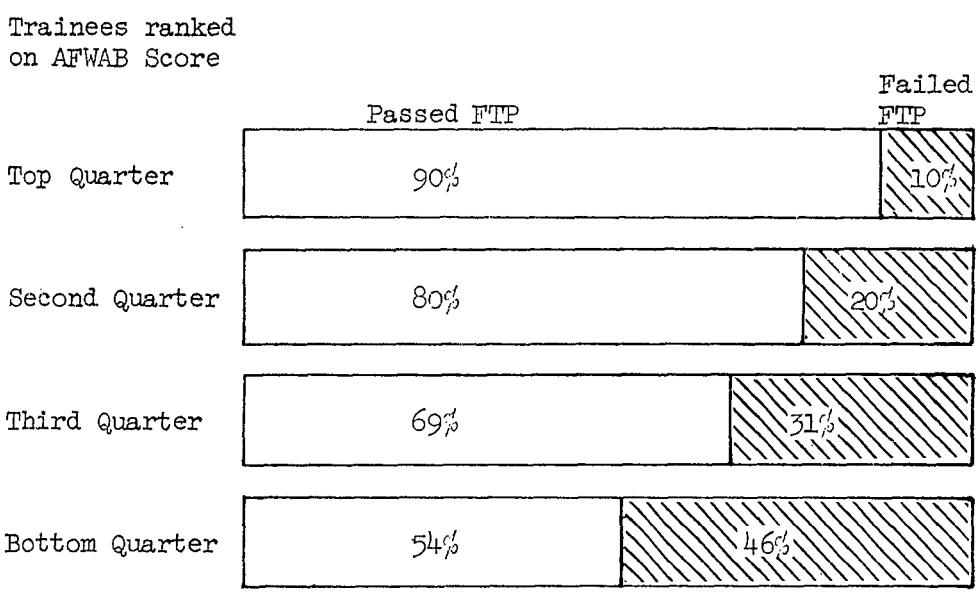

Figure 1. Comparative success in Army Primary FTP of 1109 trainees ranked on AFWAB score.

AFWAB Component Tests

Intercorrelation coefficients of the component tests ranged from .14 (Background Information Test vs Aircraft Orientation) to .53 (Mechanical Principles vs Flight Visualization). In the light of the obtained validity and intercorrelation coefficients, elimination of any of the tests from the battery would not appear advisable.

Two tests of the battery--the Aeronautical Information Test (AIT) and the Flight Visualization Test (FVT)--yielded inconsistent results in the several subsamples. Mean AIT score of the 809 men who were tested only after admission to FTP was more than 4 points higher than the mean for the remainder of the total sample. On the FVT, the mean score was 3.3 points lower. In both instances, the difference is significant far

beyond the .01 level. The atypical test performance of these men was obscured by their mean score for the complete battery, which was comparable to mean total AFWAB score for the rest of the sample.

The Aeronautical Information Test appears to be very sensitive to prior flight training. Mean AIT score of a subsample of 109 men who had had ROTC flight training between first taking the AFWAB and experimental testing at Camp Gary showed a gain of approximately two standard deviations from first to second testing. A subsample of 191 who had taken the AFWAB operationally before coming to Gary but who had had no intervening flying experience showed a gain in mean of less than two-thirds of a standard deviation (Table A-4). In brief, previous flying experience appears to inflate the AIT score to a considerable extent.

ROTC Flight Training and Attrition

Among men with ROTC flight training, a greater percentage successfully completed the Army Flight Training Program than among other trainees (94% versus 72%). The finding is consistent with results of a 1954 Air Force study covering 1948-49 pilot trainees, wherein a phi coefficient of .36 between previous flying experience and success in pilot training was reported (Tucker, 1954).

Optimal vs Unit Weighting of Component Tests

In the present operational use of the AFWAB, component test scores are unit weighted. In the present sample, unit weights results in a validity coefficient of .41, compared with a coefficient of .43 obtained with optimal weights. When shrinkage was estimated, the multiple correlation coefficient dropped to .42. In brief, the unit-weighted system of computing battery scores resulted in the same predictive efficiency as did the administratively more cumbersome optimal weighting.

Cutting Score Data

Using the unit-weighted validity coefficient, data on the flight training success of the 1109 trainees in the sample were analyzed to estimate the effect of various AFWAB cutting scores on attrition rate. Table A-5 of the Appendix shows, for trainees who would have been accepted under a given AFWAB cutting score (had the AFWAB been used operationally), the percentage passing FTP and the percentage failing. Table A-6 provides like information on trainees who would have been rejected under various AFWAB cutting scores.

CONCLUSIONS

The validity coefficient of .41 indicates that the AFWAB is a moderately effective instrument for predicting success in the Army Primary

Fixed-Wing Flight School course. Validity and intercorrelation coefficents obtained for component tests of the AFWAB indicate that it would not be advisable to eliminate any of the tests from the battery. The currently used unit weighting of AFWAB subtest scores is satisfactory.

REFERENCES

1. Christal, R. E. and Krumboltz J. D. Use of the Air Force Officer Qualifying Test in the AFROTC Selection Program. Technical Memorandum PL-TM-57-6. Personnel Laboratory, Air Force Personnel and Training Research Center, Lackland Air Force Base, San Antonio, Texas. February 1957.

2. Tucker, J. A., Jr. Use of Previous Flying Experience as a Predictor Variable. Research Bulletin AFPTRC-TR-54-71. Air Force Personnel and Training Research Center, Lackland Air Force Base, San Antonio, Texas. 1954.

Appendix Table A-1

VALIDITY COEFFICIENTS[a] AND INTER-r's OF AFWAB COMPOSITE AND SUBTEST SCORES FOR THE PASS-FAIL FTP CRITERION
(N = 809 men tested only at Camp Gary)

	Variable	Mean	S.D.	Intercorrelation coefficients						
1.	Background Inventory	9.62	3.62	1						
2.	Aeronautical Information	10.75	6.05	.31	2					
3.	Mechanical Principles	15.31	5.75	.24	.38	3				
4.	Aircraft Orientation	10.30	6.02	.15	.30	.43	4			
5.	Flight Visualization	9.71	7.85	.16	.33	.57	.50	5		
6.	AFWAB Composite Score	55.69	20.69	.44	.67	.77	.72	.81	6	
7.	Criterion (Pass-Fail Training)	.71	.45	.15	.45	.28	.25	.30	.42	7[a]

[a]Biserial validity coefficients.

Appendix Table A-2

VALIDITY COEFFICIENTS[a] AND INTER-r's OF AFWAB COMPOSITE AND SUBTEST SCORES FOR THE FLYING DEFICIENCY CRITERION
(N = 740 men tested only at Camp Gary)

	Variable	Mean	S.D.	Intercorrelation Coefficients						
1.	Background Inventory	9.63	3.64	1						
2.	Aeronautical Information	10.92	6.06	.32	2					
3.	Mechanical Principles	15.42	5.67	.24	.37	3				
4.	Aircraft Orientation	10.42	6.05	.16	.29	.43	4			
5.	Flight Visualization	9.91	7.83	.16	.31	.56	.50	5		
6.	AFWAB C m-posite Score	56.36	20.65	.45	.66	.77	.71	.80	6	
7.	Criterion (Pass-Fail Flying Deficiency)	.78	.41	.18	.46	.22	.18	.23	.32	7a

[a]Biserial validity coefficients.

Appendix Table A-3

RELATION OF ARMY FIXED-WING APTITUDE BATTERY TO SUCCESS IN FLIGHT SCHOOL

(Based on One Year's Input into Camp Gary, Texas)

Quarter of Group on AFWAB	No. of Students in Quarter Passing Primary	No. of Students in Quarter Failing Primary	Total Number of Students in Quarter	% of Students in Quarter Passing Primary
Top Quarter	248	29	277	90
Second Quarter	223	56	279	80
Third Quarter	194	89	283	69
Bottom Quarter	146	129	270	54
Total Group	811	298	1109	73

Appendix Table A-4

MEANS AND STANDARD DEVIATIONS OF AFWAB SCORES FOR FIRST AND SECOND TESTING FOR SUBSAMPLES WITH AND WITHOUT PREVIOUS FLIGHT TRAINING IN ROTC

Variables	Previous Flight Training (N=40)				Previous Flight Training (N=69)				No Previous Flight Training (N=191)			
	1st Testing		2nd Testing		1st Testing		2nd Testing		1st Testing		2nd Testing	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
1. Background Inventory	10.20	3.50	10.12	3.27	9.84	3.46	10.87	3.44	10.40	3.25	9.84	3.58
2. Aeronautical Information	6.30	4.86	15.28	3.81	6.33	4.49	15.83	4.46	6.74	5.19	10.11	5.44
3. Mechanical Principles	17.15	5.13	18.82	4.97	18.17	5.32	19.41	5.14	14.80	5.61	16.07	5.51
4. Aircraft Orientation	13.55	6.47	15.38	7.08	14.75	6.01	14.93	5.87	10.60	5.68	13.70	6.04
5. Flight Visualization	13.50	8.61	17.40	7.74	15.12	7.00	20.01	5.59	14.02	7.44	15.97	7.07
6. AFWAB Composite Score	62.50	18.96	77.00	20.77	64.22	18.07	81.13	16.03	56.82	18.48	65.70	18.54
7. Criterion (Pass-Fail Training)	.85	.36	.85	.36	.99	.12	.99	.12	.69	.46	.69	.46

Appendix Table A-5

RELATION OF VARIOUS AFWAB CUTTING SCORES TO ATTRITION DURING TRAINING FOR STUDENTS ACCEPTED FOR PRIMARY FLIGHT TRAINING (N = 1109)

Hypothetical		Actual	
AFWAB Cutting Score	% Accepted	% Passing*	% Failing
25	95	75	25
31	90	77	23
35	85	78	22
39	80	78	22
43	75	79	21
47	70	80	20
50	65	82	18
53	60	84	16
56	55	84	16
59	50	85	15
62	45	86	14
65	40	85	15
68	35	87	13
72	30	89	11
76	25	90	10
79	20	89	11
84	15	95	5
90	10	94	6
96	5	90	10

[a]%passing of those accepted for training. For example, if a cutting score of 59 on AWAB were adopted, 50% of the applicants would have been accepted for training. In the total sample, 85% of the 50% actually passed primary flight training.

Appendix Table A-6

RELATION OF VARIOUS AFWAB CUTTING SCORES TO ATTRITION FROM TRAINING FOR STUDENTS REJECTED FOR FLIGHT TRAINING (N = 1109)

Hypothetical		Actual	
AFWAB Cutting Score	% Rejected	% Passing[a]	% Failing
25	5	30	70
31	10	41	59
35	15	44	56
39	20	52	48
43	25	54	46
47	30	56	44
50	35	57	43
53	40	58	42
56	45	60	40
59	50	61	39
62	55	63	37
65	60	65	35
68	65	66	34
72	70	66	34
76	75	68	32
79	80	69	31
84	85	69	31
90	90	71	29
96	95	72	28

[a] %passing of those rejected from training. For example, if a cutting score of 59 were adopted, 50% of the applicants would have been rejected from training. In the total sample, 61% of the 50% would have actually passed primary flight training.

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(DA Project 2L95-60-001) Unclassified Report

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