DOCUMENT RESUME

ED 050 342 AC 010 332

AUTHOR	Boyles, Wiley R.; Wahlberg, James L.
TITLE	Prediction of Army Aviator Performance: Description of a Developing System.
INSTITUTION	Human Resources Research Organization, Alexandria, Va.
SPONS AGENCY	Office of the Chief of Research and Development (Army), Washington, D.C.
REPORT NO	PP-5-71
PUB DATE	Apr 71
NOTE	12p.; Paper presented at Annual Meeting of Alabama Psychological Association, May 1970
EDRS PRICE	EDRS Price MF-$0.65 HC-$3.29
DESCRIPTORS	*Aircraft Pilots, *Flight Training, *Military Personnel, *Predictive Validity

ABSTRACT

The development of a multivariate prediction system aimed at having useful predictors available early in the training of potential Army aviators is discussed. Using this system, supervisors will be able to relate a predictor score to a probability table, thus enabling administrators to make early decisions involving further training of Army aviators. (Author/DB)

Professional Paper 5-71

ED050342

F-DOD
AC

HumRRO

Prediction of Army Aviator Performance: Description of a Developing System

Wiley R. Boyles and James L. Wahlberg

HUMAN RESOURCES RESEARCH ORGANIZATION
300 North Washington Street • Alexandria, Virginia 22314

Presentation at
Alabama Psychological Association
Annual Meeting
Destin, Florida May 1970

April 1971

Prepared for

Office of the Chief of Research and Development
Department of the Army
Washington, D.C. 20310

AP 332

1

The Human Resources Research Organization (HumRRO) is a nonprofit corporation established in 1969 to conduct research in the field of training and education. It is a continuation of The George Washington University Human Resources Research Office. HumRRO's general purpose is to improve human performance, particularly in organizational settings, through behavioral and social science research, development, and consultation. HumRRO's mission in work performed under contract with the Department of the Army is to conduct research in the fields of training, motivation and leadership.

The contents of this paper are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

Published
April 1971
by
HUMAN RESOURCES RESEARCH ORGANIZATION
300 North Washington Street
Alexandria, Virginia 22314

1. Report No.
Professional Paper 5-71

2. Government Accession No.

3. Recipient's Catalog No.

4. Title and Subtitle
Prediction of Army Aviator Performance: Description of a Developing System

5. Report Date
April 1971

6. Performing Organization Code
PREDICT

7. Author(s)
Wiley R. Boyles and James L. Wahlberg

8. Performing Organization Report No.
PP 5-71

9. Performing Organization Name and Address
Human Resources Research Organization
300 North Washington Street
Alexandria, Virginia 22314

10. Work Unit No.
15-13

11. Contract or Grant No.
DAHC 19-70-C-0012

13. Type of Report and Period Covered

12. Sponsoring Agency Name and Address
Office, Chief of Research and Development
Department of the Army
Washington, D.C. 20310

14. Sponsoring Agency Code

15. Supplementary Notes
HumRRO Division No. 6 (Aviation), Fort Rucker, Alabama; paper presented at the Alabama Psychological Association annual meeting, May 1970.

16. Abstract

In this paper the development of a multivariate prediction system aimed at having useful predictors available early in the training of potential Army aviators is discussed. Using this system, supervisors will be able to relate a predictor score to a probability table, thus enabling administrators to make early decisions involving further training of Army aviators.

17. Key Words
Army Aviators
Aviation Attrition
Aviation Training
Criterion Development
Performance Prediction

18. Distribution Statement
Approved for public release; distribution unlimited.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	12	

Prefatory Note

This paper contains a summary of portions of the research begun under Exploratory Research 70, Longitudinal Analysis of Aviator Performance, and continued under Work Unit PREDICT, Predicting Aviator Success in Training and Operational Assignments. The research was conducted by the Human Resources Research Organization, Division No. 6 (Aviation), Fort Rucker, Alabama.

PREDICTION OF ARMY AVIATOR PERFORMANCE: DESCRIPTION OF A DEVELOPING SYSTEM

Wiley R. Boyles and
James L. Wahlberg

For the past several years, a portion of the work effort of HumRRO Division No. 6 (Aviation) at Fort Rucker, Alabama, has been devoted to the development of a data bank containing information on the characteristics of Army aviators and descriptions of their performance.

Preliminary phases of various aspects of this effort have been described in earlier papers. In 1967, Prophet reported on work toward developing a noncognitive predictor of performance based on reactions to threat of physical harm (1). In 1968, Boyles described further stages in the development of that measure (2). Prunkl and Boyles (3) reported on an aspect of the work devoted to development of a combat criterion, and Boyd and Boyles (4) discussed the use of attitudinal items from questionnaires as predictors of aviator retention in service.

The purpose of this paper will be to describe the broad framework in which these varied researches are being done and to discuss some of the more recent results. First, we are operating in the context of a very expensive training program—expensive, and very complex in nature. The knowledges and psychomotor skills being imparted to the students are complicated technical ones and involve behaviors that are very hard to predict or control. Because of the complexity of these behaviors, knowledge of the values of many component variables is necessary for good description. We attempt to predict these behaviors in a situation in which failure to predict or control with maximum efficiency results in a tremendous amount of money wasted in a very short time. The Army has been training about 600[1] new aviators per month in a program that requires about one year to complete. A rough but conservative estimate of the cost per student is $40,000—a minimum of a 24-million dollar per month training investment.

One advantage of the situation, from the measurement point of view, is that it furnishes a large number of subjects in a short period of time. This affords an excellent opportunity to examine a large number of variables simultaneously, and anything approaching an adequate description of the events occurring in this type of program requires that kind of examination.

A complication, however, stems from the fact that data require a year to mature when the criterion is successful completion of training, and over two years to mature when the criterion is job performance. The job is a year's combat performance in Vietnam for virtually all graduates. On-site data collection for this job has obvious drawbacks, one of the greatest of these being the necessity of non-interference in behavior that is often a life or death matter. So, job performance data are being gathered as soon as possible after completion of the job.

[1] The number of aviators being trained has been reduced since the time of this research because of changing military requirements.

Let me briefly describe the sequence of selection, training, and job performance and the data we are collecting (or have collected) at various stages:

For all potential aviators, the first step toward the training program is successful performance on the primary selection instrument, the Flight Aptitude Selection Test Battery (FAST), developed by the Army's Behavior and Systems Research Laboratory. It contains a number of tests which attempt to tap several aspects of cognitive aptitude for aviation and some pertinent biographical information. The psychometric characteristics of the test battery as a primary selection instrument have been described by Kaplan (5).

In the PREDICT research, Flight Aptitude Selection Test scores are being deposited in the data bank. Previously reported research (6) has shown that these scores are good predictors of whether students will fail to complete the program because of poor flying performance.

The Navy has for several years used a multivariate prediction system in secondary selection and their system is built around the use of similar battery (7). This, of course, is in spite of the attenuation of prediction resulting from use of the batteries as primary selectors in both services.

The applicant who equals or surpasses the FAST cut-off score and meets the several other requirements for entrance into the program goes directly to the primary flight school if he has already completed Basic Combat Training (BCT). For the last several years, however, about half the input to Army flight training has consisted of young men coming into the program from civilian life. These men must successfully complete BCT before entering the flight program proper.

The 8-week BCT program involves, among other things, physical training, marksmanship training, and introductions to military discipline and tactics. Using the evaluations made of the trainee throughout this period, we have collected data on more than 50 variables for each of 1,500 BCT students.

Some preliminary analyses of these data have been completed and have shown promise for predicting a troublesome behavior called "Snobird" attrition—attrition from the training program, often at the trainee's request, occurring after the completion of BCT but prior to entrance into "preflight" training. In a high volume program such as Army aviation training, unpredictable fluctuations in weather (scheduling the start and finish dates for training depends on the weather and is necessarily less than precise), supply of recruits, and demand for graduates often result in over-supplies of personnel at various points during training. The trainee who arrives at the primary training center and has a delay facing him before admission to preflight training is termed a "Snobird." The Snobird population at one of the centers has sometimes been as large as 600 and the length of the delay is sometimes several weeks. Resignations and other personnel losses occur with disturbingly high frequencies during peak Snobird periods, and identification of high-probability eliminees prior to entry into this status has potential for reducing transportation and training costs.

Prunkl and Tomolonis are conducting the PREDICT study of the 50 BCT variables, and their preliminary results show, for example, a point-biserial correlation of .21 between scores on a physical proficiency test administered early in BCT and subsequent Snobird attrition. This relationship is significant at the .01 level.[2] The comprehensive evaluation of their predictors, both against Snobird attrition and against flight training criteria, will be completed at a later date.

Once a trainee has passed the BCT and Snobird hurdles, he enters preflight training, where quantitative data generated include academic examination scores in military development subjects and in aviation subjects. There are two primary classifications of student aviators in the Army: one is the warrant officer candidate (WOC), who is an

[2] Prunkl, Peter R., and Tomolonis, Peter C.: Personal Communication.

enlisted man during training and becomes an aviation warrant officer upon graduation; the other is the officer student, who has received a commission or warrant prior to entering the aviation program. Although both are awarded Army aviator ratings at graduation, the training for the two types of students is slightly different. There are, therefore, slightly different sets of information available for the two types, and this has implications for the design of the PREDICT research.

After a preflight period of four weeks for warrant officer candidates and approximately two weeks for officer students, actual flying training begins, the first, or primary, portion of which is 16 weeks long. During this period, each student receives about 50 grades on flying ability. The warrant officer candidate accumulates 27 academic grades and the officer student 21 during primary training. All of these grades are placed in the HumRRO data bank. Upon completion of primary training, the student attends advanced training at Fort Rucker for an additional 16 weeks. The grades for each flight and for each academic examination administered there are included in the data bank. Graduation comes at the end of that period.

Consider now the task of the administrator in this program. He may be called upon at any point during the student's training period to decide whether a marginal student should be:

(1) Retained in the program and allowed to continue with his original class.
(2) Retained, but given extra training to correct his academic, flight or military deficiencies.
(3) Eliminated from the program.

Eliminating a student who could complete the program is costly because a substantial investment will be wasted and a replacement must be trained at further cost. Retaining a student who is highly likely to fail to complete the program is also wasteful. The administrator, therefore, must make accurate decisions as early as possible. Typically, however, he is faced with much more data on the individual than he can possibly absorb and integrate into his decision in the short time allotted him. The result is inevitably selection of portions of the data on the basis of personal experience, which would vary greatly from one administrator to the next. Comparative and cumulative validities of variables available as potential predictors are generally unknown.

The PREDICT project is in the process of developing a multivariate prediction system which can use all the data available on the marginal student, up to the point in training at which a decision must be made as to his retention or elimination. From the mass of data, the system will select the most valid predictors, properly weight them (i.e., on an empirical basis), and furnish the administrator with a predictor score which he can relate to a probability table. An example of such a table will be given later in the paper.

Another important decision that must be made by aviation training administrators involves selection for specialized training. An important current example is helicopter gunnery training. About one-fourth of the aviators are currently selected for this training and the current method of selection is random. An attempt was made to select on the basis of flight grade-point average but this method appeared to training administrators, on a subjective basis, to produce poorer results. Now a large number of potential predictors are available to compare against final training grades in gunnery, and soon it will be possible to see how well the available data predict this performance.

Even if this prediction is reasonably accurate, the job will be far from complete. While it has been shown that quality of training performance in military aviation is related to quality of operational performance (8), the correlation is far from perfect. Thus, simultaneously with the preparation for validation against training criteria, a PREDICT team has been engaged in the development of a measure of job performance (3, 9). This must be done simultaneously, because the requirement for the job—combat flying—may, hopefully, disappear soon.

We have begun collecting validation data (in the form of peer nominations, which seem the best initial measure of combat performance) from aviators returning from Vietnam. The number will grow at the rate of several hundred per month.

A further problem, in addition to that of developing a job performance measure, is that a number of useful predictor measures are not now being generated in the Army system, and others require some evaluation before being used in the prediction system. One of these is a peer rating taken during training. Wahlberg (10) has reported on an ongoing study of peer ratings as predictors of aviator performance.

The PREDICT research is moving in these various directions simultaneously because it is necessary, for good multivariate analysis, to have all potentially useful measures available on the same cases—and when the cases are as mobile and as busy as Army aviators, rapid processing is essential.

All these studies are aimed at a single goal: to have a comprehensive description of the subject's characteristics available at all points in his training and operational development, and to have *all* the valid predictors available at a point in time for use in manpower management decisions. Substantial, though perhaps not smooth, progress is being made toward that goal.

Some of the results of the exploratory work into prediction of completion or attrition during initial rotary wing training is given for a relatively small sample of 715 subjects. The main analyses will be based on subgroup *N*s well in excess of 2,000. The data in this paper represent a partial evaluation of (a) FAST component scores, (b) averages of daily flight grades at two early points in training, and (c) scores on a measure of voluntary exposure to physical harm threat, the Background Activities Inventory (BAI). The criterion variable is the dichotomy of completion versus failure to complete the flight training program.

Table 1 contains the bivariate correlations between these variables and completion of training for one subject classification: Warrant Officer Candidates who came into the program directly after basic training. This table reflects data that are available during the preflight stage of training, and, thus, there are no flight performance variables included in this analysis. Table 2 lists the cumulative shrunken multiple *R*s for variables selected by the Wherry-Doolittle procedure for this point in training. Table 3 is a probability table based on the regression equations derived from this matrix.

Table 1

Variables Used in the Initial Matrix
Warrant Officer Candidates
Weeks 1 Through 4

Variables	Fail (rpb)	Mean
1. Instrument Comprehension	.137	17.72
2. Mechanical Information	.114	14.73
3. Complex Movements	.197	24.13
4. Visualization of Maneuvers	.063	18.51
5. Helicopter Knowledge	.141	10.36
6. Stick and Rudder Orientation	.197	25.99
7. Aviation Information	.134	9.32
8. Mechanical Functions	.144	15.35
9. Background Activities Inventory (BAI)	.070	34.30

Table 2

Cumulative R For Predictor Variables
Warrant Officer Candidates
Weeks 1, 2, 3, and 4

	Completed	Failed	Total
N	591	124	715

Shrunken Multiple *R* (Point Biserial) With Complete/Attrite

Variable	Cumulative *R*
Complex Movements	.197
Stick and Rudder Orientation	.250
Mechanical Functions	.265
Aviation Information	.273
Background Activities Inventory (BAI)	.277 (R_b equivalent .412)

Table 3

Probability Table
Enlistment Option Warrant Officer Candidates
Weeks 1, 2, 3, and 4

	Percent of Total	Number Complete	Number Drop	Approx. Odds		Percent Graduated
				For	Against	
1050 and Higher	10	68	2	34	1	97
900-1049	45	289	36	8	1	89
850-899	18	102	27	4	1	79
800-849	12	65	23	3	1	74
750-799	8	40	15	2.67	1	73
700-749	5	23	12	2	1	68
Under 700	2	4	9	1	2	31
Totals	100	591	124	4.75	1	83

The first eight variables shown in Table 1 are eight subtests of FAST, the primary selection instrument. The ninth is the aforementioned measure of voluntary exposure to threat of physical harm, the Background Activities Inventory. This first analysis, covering the first through fourth week of training, consists entirely of paper-and-pencil tests. As flying does not begin until the fifth week of training, the seventh and eighth weeks of training, shown on Table 4, are the third and fourth weeks, respectively, of flying activity for the students. It is interesting to note the increase in the multiple *R* (Table 5) and the changes in the probability table (Table 6), once training performance measures are included in the matrix. A somewhat arbitrary division has been made of flying grade ··nt averages in the second matrix, into the first five graded flights and the sixth

through fourteenth graded flights. This is not entirely arbitrary, however, a student is rarely removed from the program for flying deficiencies until he has had five graded flights, while he may be removed on any graded flight thereafter.

This is a somewhat inexact prediction when compared to explanation of all variance but, compared to what one person is able to do when faced with an individual subject's scores on this same set of variables, it is good—good enough, in fact, to justify the construction of the more elaborate system which has been described in this paper. This will allow the construction of the best prediction system possible within the constraints of current multivariate analytic techniques, and within the limits of reliability of the

Table 4

Variables Used in Second Matrix
Warrant Officer Candidates
Weeks 7 and 8

Variables	Fail (rpb)	Mean
1. Instrument Comprehension	.122	17.85
2. Mechanical Information	.094	14.83
3. Complex Movements	.170	24.37
4. Visualization of Maneuvers	.043	18.56
5. Helicopter Knowledge	.104	10.46
6. Stick and Rudder Orientation	.223	26.03
7. Aviation Information	.100	9.46
8. Mechanical Functions	.151	15.41
9. Background Activities Inventory (BAI)	.077	34.34
10. Graded Flights 1-5	.293	2.62
11. Graded Flights 6-14	.446	2.37

Table 5

Cumulative R For Predictor Variables
Warrant Officer Candidates
Weeks 7 and 8

	Completed	Failed	Total
N	590	98	688

Shrunken Multiple *R* (Point Biserial) With Complete/Attrite

Variable	Cumulative *R*
G.P.A. Graded Flights 6-14	.446
Stick and Rudder Orientation	.469
Mechanical Functions	.483
Mechanical Information	.501
Helicopter Knowledge	.511 (R_b equivalent .797)

Table 6

Probability Table
Enlistment Option Warrant Officer Candidates
Weeks 7 and 8

	Percent of Total	Number Complete	Number Drop	Approx. Odds		Percent Graduated
				For	Against	
1200 or More	04	30	0	No Failures		100
800-1199	56	369	19	19	1	95
551-799	27	151	33	4.5	1	82
400-550	10	35	33	Even		51
200-399	2	5	10	1	2	33
199 or Less	<1	0	3	No Successes		00
Totals	100	590	98	6	1	86

criteria available. It is worth noting that the Background Activities Inventory (BAI), which makes a small, but significant, contribution to the multiple R in the matrix for the first four weeks of training, is now undergoing item analysis, and the revised version should give significant improvement of prediction. Further, it is worth attention that, while flight grades comprise most of the prediction at the seventh and eighth weeks, the FAST component scores substantially raise the multiple R.

The particular FAST subtests selected differ from those selected in the first analysis. The equivalent biserial values at both stages exceed those reported by the Navy in use in a system which has been highly satisfactory for naval aviation (11). We are confident that our first comprehensive matrices will give substantially improved prediction. It is also hoped that the PREDICT project will give as great a stability of prediction as the Navy multiple Rs which have held up extremely well from year to year.

LITERATURE CITED

1. Prophet, Wallace W. *Human Factors in Aviation: Some Recurrent Problems and New Approaches*, HumRRO Professional Paper 30-67, June 1967.
2. Boyles, Wiley R. *Background and Situational Confidence; Their Relation to Performance Effectiveness*, HumRRO Professional Paper 22-68, June 1968.
3. Prunkl, Peter R., and Boyles, Wiley R. *A Preliminary Application of the Critical Incident Technique to Combat Performance of Army Aviators*, HumRRO Professional Paper 24-68, June 1968.
4. Boyd, H. Alton, Jr., and Boyles, Wiley R. *Statements of Career Intentions; Their Relationship to Military Retention Problems*, HumRRO Professional Paper 26-68, July 1968.
5. Kaplan, H. *Prediction of Success in Army Aviation Training*, Technical Report 1142, U.S. Army Personnel Research Office, 1965.
6. Boyles, Wiley R. *Measures of Reaction to Threat of Physical Harm as Predictors of Performance in Military Aviation Training*, HumRRO Professional Paper 15-69, May 1969.
7. Shoenberger, R.W., Wherry, R.J., Jr., and Berkshire, J.R. *Predicting Success in Aviation Training*, Research Report, U.S. Naval School of Aviation Medicine, U.S. Naval Aviation Medical Center, Pensacola, Florida, September 1963.
8. Rickus, George M., Jr., and Berkshire, James R. *Development of an Aviation Combat Criterion: Preliminary Report*, NAMI-1047, Naval Aerospace Medical Institute, Naval Aerospace Medical Center, Pensacola, Florida, August 1968.
9. Boyles, Wiley R., Prunkl, Peter R., and Wahlberg, James L. *Combat Aviator Criterion Development*, HumRRO Professional Paper 34-69, November 1969.
10. Wahlberg, James L., Boyles, Wiley R., and Boyd, H. Alton. *Peer Ratings as Predictors of Army Aviator Performance*, HumRRO Professional Paper 1-71, March 1971.
11. Berkshire, J.R. *The Pensacola Student Prediction System: Progress Report*, Special Report 65-1, U.S. Naval School of Aviation Medicine, U.S. Naval Medical Center, Pensacola, Florida, January 1965.