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Predicting the Potential for Active Duty Success of Rehabilitated Air Force Prisoners

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AEROSPACE MEDICAL DIVISION
AIR FORCE SYSTEMS COMMAND
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NOTICE

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FOREWORD

This research was carried out under Project 7719, Development of Procedures for Increasing the Efficiency of Selection, Evaluation, and Utilization of Air Force Personnel; Task 771901, Mathematical and Statistical Techniques to Facilitate Research on the Utilization of Air Force Personnel.

The study which is reported here is a continuation of work begun in 1964 under the direction of Dr. B.C. Graves, then with the 3320th Retraining Group, and Dr. Joe H. Ward, then with the 6570th Personnel Research Laboratory. As a result of these early efforts, it was possible to convert segments of a data base which had been accumulated at the Retraining Group since 1952 into a manageable form for computer processing. Moreover, several initial analyses were conducted. The analyses were related primarily to the question of how classification board personnel at the Retraining Group were using information derived from the Minnesota Multiphasic Personality Inventory and other indicators of psychological adjustment in arriving at decisions to discharge or to return to active duty retrainees at the Group. Much of the success of the present study is due to the efforts of these investigators in bringing to light limitations and possibilities inherent in the data base.

The present study is the result of a joint effort by personnel at the Retraining Group and the Personnel Research Laboratory. It is not possible to draw clean lines which separate the efforts of the authors. Lt. Thomas H. Smith, through the facilities of the Retraining Group, provided the data base for the current study. He also was primarily responsible for the definition of the extensive array of generated variables used in the analyses, as well as for formulating and preparing the report of the study. Computer runs were made at the Personnel Research Laboratory. Development of computer programs for the editing of input data and for completing the data processing and analyses was under the direction of Mr. C. Deene Gott. Formulation of the analysis procedures and the procedure for making findings applicable in the operational context of the Retraining Group reflect the efforts of Dr. Robert A. Bottenberg.

This report has been reviewed and is approved.

James H. Ritter, Colonel USAF
Commander

J.W. Bowles
Technical Director

ABSTRACT

This report documents the progress in developing and validating a prediction device for use in aiding decisions to return to active duty or discharge Air Force prisoners sent to the Retraining Group. First, there is an extensive review of the methodology and results of efforts to predict delinquency, recidivism, and military unsuitability. Then, two multiple regression analyses made on a sample of 1,303 former retrainees are reported. Each of the analyses yielded encouraging results in an initial cross-validation on 138 more recent retrainee cases for which actual criterion data were available. The cross-validation procedure was limited to making predictions on only 71 cases where the value of the multiple regression predicted score was sufficiently high or low to assure satisfactory accuracy. The best of the two regression equations, a 13-predictor system, was 77.4 per cent accurate in predicting successful return to duty and 72.5 per cent accurate in predicting unsuccessful return to duty. Details for applications of such a system, once adequately validated, to the operational decision-making process of the Retraining Group are given.

TABLE OF CONTENTS

LIST OF TABLES

PREDICTING THE POTENTIAL FOR ACTIVE DUTY SUCCESS OF REHABILITATED AIR FORCE PRISONERS

I. PURPOSES OF THE PROJECT

The mission of the Air Force's 3320th Retraining Group is to return to active duty as many of the Air Force prisoners sent to it as possible and to discharge the remainder. By attempting to prepare prisoners referred from the field for return to duty, the Retraining Group serves the Air Force in two ways. It identifies those who should be removed from the Air Force and administers the appropriate discharge; and it returns to duty those who, despite court-martial conviction, respond to the retraining program and are likely to be valuable personnel resources.

Deciding whether a given retrainee[1] is likely to succee if returned to active duty from prisoner status has always been and undoubtedly will always be left up to human judges. In making such decisions the judges have attempted to take into account background information – an individual's family, school, police, military, and offense-related history – as well as results on selected objective psychological tests. Because of the magnitude of information available on each retrainee and because the relationship of this information to successful return to duty is by no means factually certain, the manner in which individual decision-makers should use psychosocial data has been an unanswered question. It is hardly disputable that improvements can be made in the use of such data in deciding who should and who should not be returned to duty from the Retraining Group.

In 1964 the Retraining Group began systematically to encode data on 139 variables for all retrainees passing through the program from the beginning of the Retraining Group's existence in 1952. (Individual files on all cases had been preserved.) This effort has continued, and all cases through the present have been similarly encoded. It was felt that powerful multivariate statistical techniques could be used to analyze the relationships of such psychosocial variables to the criterion of successful return to active duty. The results of such an analysis should enable more systematic and accurate use of psychosocial information in making decisions on retrainees currently passing through the retraining program.

There is no intention that this project test any hypotheses about the unique predictive power of individual variables or particular combinations. Instead, it is intended to demonstrate that a prediction instrument can be derived from the statistical analysis of a large number of personal background variables for which data are easily obtained.

In addition to the possibility of developing an operational aid to decision-making, there is considerable curiosity from a theoretical point of view about background and personality factors which may cause delinquency as seen in the Retraining Group population and which seem to predispose a delinquent to benefit from a rehabilitation program. Although satisfying this curiosity is definitely a very secondary objective of the present project, it is an interesting one none the less.

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[1] The term retrainee designates those Air Force prisoners sent to the Retraining Group. Decisions to send prisoners to the Retraining Group are made by commanders in the field and are in no way controlled by the Group. The prisoners who are referred generally have been convicted of minor criminal and military offenses.

II. BACKGROUND OF THE PROJECT

This paper is a progress report on the first attempt to predict from a variety of psycho-social variables the rehabilitation success of Air Force enlisted men returned to active duty after conviction and confinement under the Uniform Code of Military Justice. (Graves, 1963, attempted to predict recidivism among retrainees using the scales of the MMPI alone.) While being the first of this kind, the present study is related to studies which have attempted to predict success of parolees of civilian corrections institutions, to identify delinquents at an early age, and to predict unsuitability among military enlisted personnel. The difference between the present project and those of the foregoing three categories goes beyond the obvious differences in populations, variables, and criteria studied; it rests largely on the fact that the present study has analyzed comprehensively an unusually large number of predictor variables and has produced an operational aid to the prediction of human behavior which compensates for the strengths and weaknesses of the statistical analysis involved. It is in terms of the large number of variables analyzed and the production of an operational instrument which, in a manner of speaking, "knows its own limitations" that this present study would seem to make a contribution.

Because the present study obviously has a good deal in common with the three types of work mentioned, the substantive and methodological contributions of some of those studies are reviewed in the following sections.

Identification of Variables Related to Crime, Rehabilitation, and Unsuitability

This section presents a general view of the types of variables which have been used in some of the more recent prediction attempts. The variables discussed have been revealed through analytic or heuristic investigation of multiple predictors, and then only when such investigations have yielded a set of predictor variables with some demonstrated validity or statistical significance.

Lejins (1962) and Graves (1963) give accounts of statistical prediction in crime and corrections, indicating the interest as early as 1923 in using tests and background variables to predict delinquency, parole success, and recidivism. Researchers empirically weighted several variables in order to yield prediction tables based on the variables in combination. These tables could be used to calculate a prognostic score or expectancy rate for youths for whom delinquency prediction is desired and for individuals eligible for parole. Probably the most celebrated among such efforts is the Glueck Social Prediction Table, derived from studies which began in the 1930's and continue today. (See Glueck & Glueck, 1950; E.T. Glueck, 1966a, 1966b.) This instrument applies weights to the values of three, four, or five predictor variables in order to classify youths according to their likelihood of becoming delinquent. The three variables used in that variation of the Social Prediction Table claimed to be valid were supervision of boy by mother, discipline of boy by mother, and family cohensiveness (Craig & Glick, 1963; Trevvett, 1965). Many other predictor variables suggested in Glueck and Glueck (1950) have been cast into tables published, for example, by E.T. Glueck (1963, 1966a, 1966b).

More recently initiated is the work reported by Beverly (1959, 1964, 1965) on the development of base expectancy tables at the California Youth Authority. Several such tables have been developed, employing from four to twelve predictor variables. Those variables reported to yield the most useful tables were age at first admission, age at release, number of prior commitments, committing offense (crimes against persons *vs.* other crimes), mental rating, and race.

The work of Vichert and Zahnd (1965) yielded several useful predictors: length of sentance, age, marital status, number of previous convictions, parole supervision agency, and institution from which released. As a result of their analyses, it was possible to categorize prospective parolees among civilian prisoners as high-risk or low-risk.

Cowden (1966) rejected home environment variables as nonsignificant and concluded that the most useful predictors of recidivism in the civilian group studies were age, certain clinically determined personality ratings, and measures of institutional adjustment.

Also relevant to predicting successful return to active duty of Air Force prisoners is the considerable work done in attempting to predict punitive, undesirable, and unfitness discharges among Air Force enlisted personnel. Fisher, Ward, Holdrege, and Lawrence (1960), Gordon and Bottenberg (1962), and Flyer (1963) used as predictors number of years of formal education, scores on enlistment classification batteries (qualification and aptitude tests), basic training officer and peer rating results, and age. Essentially the same predictors were employed by Flyer (1964) in the development of an instrument to predict successful active-duty performance of first-term airmen. Age, years of schooling, and intelligence level were found useful in predicting four performance criteria for Naval enlistees by Plag and Hardacre (1965).

Methods of Selecting and Weighting Predictor Variables

When a researcher attempts to develop a means to predict a given criterion, he must have some idea beforehand as to what variables are likely to be effective predictors. Obviously, a method of analysis which does not restrict the researcher to consideration of only a small number of variables is to be preferred, especially when little is known but a great many guesses exist about what is related to the criterion in question.

The methodology of developing prediction instruments involves two steps. The first step is to select the variables from among all those suggested by theories and hunches to be included as predictors of the criterion in question. Then some technique must be applied to estimate the influence of each of the predictor variables in determining the criterion; that is, the variables must be empirically weighted according to their importance. This step effects a multivariable summary of the prediction information and puts it into a usable form.

Selecting Variables to Analyze. Approaches which have been used to accomplish the first step range from the investigation of a small number of individual relationships about which workers have particular hypotheses to the analysis of one hundred or more possible predictors in order to find which predict most effectively. The first step is thus accomplished by different researchers in different ways. Some apparently have interest in the predictive power of a few particular variables. These workers usually restrict their attention to the testing of hypotheses about the particular variables. Examples of this approach to the selection of predictor variables are Cowden (1966), who hypothesized six individual relationships between certain predictors and the criterion of recidivism, and Air Force and Navy investigators (Fisher *et al.*, 1960; Gordon & Bottenberg, 1962; Flyer, 1963; Plag & Hardacre, 1965), who named the variables they were interested in using as predictors and then developed regression equations using only those variables.

Other researchers attempt to push their data collection capabilities to the limit by examining large numbers of predictors with an eye toward selecting only the most effective ones for use in a prediction instrument. Examples of this strategy are Glueck and Glueck (1950) who developed several five-variable prediction devices from an analysis of hundreds of possible predictors, and Beverly, who, in his earliest work (1959), selected 11 of 153 possibilities. The ways in which these selections were made were quite laborious, however. The Gluecks resorted to computing percentages of actual delinquents and actual nondelinquents for whom each predictor category held true. From these percentages they inferred which predictors discriminated best between actual delinquents and nondelinquents. Beverly made his initial selection of predictors by counting the contingencies between each of his 153 categorical predictors and two criterion categories. Inspection of these contingency counts led to the decision to enter 11 of the variables into a regression analysis.

Another problem facing the researcher after he has selected the variables he concludes to be most promising as predictors is the possible existence of interactions among individual predictor variables. The proportions this problem has assumed for researchers concerned about the question of interactions are exemplified by Beverly (1964). In that study 741 two-way interactions (each of 39 dichotomous or trichotomous variables taken in combination with every other) were tested (using chi-square) for significant relationship to the criterion. Had more interaction combinations proved significant than could have been expected merely by chance, these would have been used to construct new variables for entry into the regression analysis.

Weighting Variables. The second step consists of determining the importance or relative weight of predictor variables taken in combination. Some investigators seem to avoid the problem of weighting when they test only individual relationships between certain predictors and a criterion. Their search seems to be for single predictor variables with uniquely powerful predictive efficiency. Cowden (1966) studied individual predictors primarily, generating additional variables from interactions between some of these.

Other workers employ a variety of weighting techniques. Glaser (1962) indicates four approaches which have been used.

1. The unit weighting used in the earliest instruments developed by Burgess in 1928 provides for the assignment of one point for each characteristic a prospective parolee has in common with successful parolees in the past. These points, when summed, yield a score the size of which indicates the prospective parolee's likelihood of successful parole adjustment. The assignment of unit points in this way, however, cannot accurately reflect the relative importance of each of the variables.

2. The weighting strategy used by the Gluecks is very straightforward while offering to reflect more accurately the relative predictive power of each variable considered. Their method is to develop a score for each individual on whom a prediction is desired by considering each of the five variables individually. For each of the five categorical variables, a number is added to the individual's "failure" score equal to the percentage of test cases studied by the Gluecks for whom the attribute was true and who actually became delinquent. Thus, if a youth for whom a prediction is desired experienced lax discipline by his mother, and 70 per cent of the true delinquents originally studied by Gluecks also experienced lax discipline by their mothers, a score of 70 is credited to the individual; this score is added to similarly derived figures for the other variables. In terms of the resulting sum, the individual is placed into one of three risk categories constructed from figures compiled on 890 delinquent and nondelinquent test cases.

Such a technique, while easy to understand and apply, weights separate categories without recognizing the possible interaction effects of other variables in determining the criterion category and without taking into account the apparently high degree of correlation among the predictor variables used. (The lack of independence among predictors is evidenced by the reported high correlation coefficient between scores derived using combinations of two, three, and four variables of the original five-variable Social Prediction Table; see E.T. Glueck, 1960.)

3. Glaser (1962) offered what he has termed a configuration table as the most straightforward of the several methods of weighting and summarizing the predictive capability of multiple variables. (See also Vichert & Zahnd, 1965.) In setting up a configuration table, that variable best able to discriminate (in terms of percentages) between criterion values is used to divide the test population. Then other discriminative predictors are used to make further subdivisions, such that a user of the table can see the percentage of the test population which successfully adjusted and which also possessed each particular predictor attribute and each combination of attributes. As Glaser pointed out, a configuration table allows the user to see how each predictor variable and each combination contribute to the discrimination process so that he may more easily use the table to augment his personal experience and judgment. The configuration table arrangement also reflects interactions among variables so that the user need not rely on two or more variables which are highly correlated.

The drawback of such configuration tables is that they lack rigorous rules of construction and thus subject workers to value judgments in deciding, for example, how few cases may be placed in a single subdivision and how large differences in percentages must be to indicate significance. In addition, the tables do not make definitive predictions but, rather, allow the user to consider as much or as little of the table as he wishes.

4. The last method found in use was multiple linear regression analysis, a more mathematically complicated procedure for arriving at the optimum weights for predictor variables while systematically taking into account the intercorrelations among variables. While regression analysis requires special skills and makes the process of relating the predictors to the criterion seem perhaps more remote, the technique is more rigorous and capable of producing a prediction instrument with greater power.

Besides the work reported in this paper, the authors have found only one other instance of the application of multiple regression analysis to develop prediction instruments in corrections. In his work with the California Youth Authority, Beverly (1959, 1964, 1965) reported the development of regression equations, one of which (1964) involved as many as 12 predictor variables in predicting the criterion of successful parole adjustment.

Development of Operational Aids in Decision-Making

The actual application of prediction instruments is the final point to consider but, perhaps, the one of ultimate significance since this is the intended goal of the development of such devices.

Advances in the methodology of expressing analyses in actual operational form began when workers translated their predictions into prognostic scores or categories. For example, use of the Glueck Social Prediction Table results in the classification of each individual into one of three categories: (*a*) low chance of becoming a delinquent; (*b*) 50-50 chance of becoming a delinquent; and (*c*) high chance of becoming a delinquent. The Base Expectancy Tables of the California Youth Authority divide the range of the predicted score produced by the regression analysis into five categories; probabilities of parole success are then calculated for each of the categories. Glaser's configuration tables express the percentage of past successful parolees possessing certain characteristics in combination. These percentages can be taken as probability estimates for prediction purposes.

Operational use of the prediction instruments reviewed here has been carried out and extensively reported in only one instance found by the authors; use of the prediction instruments was suggested in another instance and was definitely discouraged in a third.

Some of the studies by the Air Force to predict unsuitability or satisfactory duty performance apparently intended to make their findings directly and operationally applicable, but only one study included the means to apply its findings operationally. Fisher *et al.* (1960) transformed a two-variable regression equation which weighted years of formal education and years of age as predictors of unsuitability on active duty into a handy cardboard rotary calculator which recruiters could use to find the probabilities of unsuitability associated with the age-education combinations offered by prospective enlistees. Making such a device available, however, does not help the user decide the extent to which he will rely on it and the extent to which he will consider other information.

On a test basis, the New York City Youth Board applied the Glueck Social Prediction Table directly to the task of predicting delinquency of children of school entrance age, starting in 1952 (Craig & Glick, 1963). The Washington, D.C. Commissioners' Youth Board made similar applications of the table beginning two years later (Trevvett, 1965). The results of the New York test showed that, of 33 boys identified as having high probability of becoming delinquents, 84.8 per cent became delinquents; of 243 boys identified as having low probability of becoming delinquents, 97.1 per cent did, in fact, remain nonoffenders. These findings prompted the New York City Youth Board to recommend employing the table operationally as apparently the sole element in a decision-making process which selects "predelinquents" for referral to an intensive treatment program. The Washington, D.C. project reported 100 per cent accuracy in predicting nondelinquency among 136 youths and 81 per cent accuracy in predicting delinquency. With these findings, the Washington, D.C. Commissioners' Youth Board announced they would begin using the table to screen youths for special attention. These proposed applications of a prediction instrument have produced heated controversy (Citizens Group, 1965; Kahn, 1965; MacDonald, 1965) on the grounds that the instrument is not thoroughly validated, that such a practice could very well result in a self-fulfilling prophesy for the youths identified as predelinquents, and that it is as yet undetermined what sort of treatment, if applied in time, will reverse the tendencies toward delinquent behavior.

In contrast to this boldness in proposing the use of the Glueck table, the California Youth Authority's attitude reflects concern for what it sees as an inadequate squared coefficient of multiple correlation. (The highest value reported by Beverly, 1965, was an R^2 of .093.) Beverly states, "In general, it has been our policy to discourage the use of base expectancy scores as a selection device to assist the Youth Authority Board in arriving at its release decisions."[2] Instead, use of the Base Expectancy Tables has been considered best restricted to enabling comparisons between the populations of several California institutions, and comparisons of treatment effects between institutions using an expectancy table to hold constant the criterion-related variables represented in the regression equations.

Perhaps more realistic than either of these attitudes toward using mathematical prediction devices in corrections is the view expressed by Lejins (1962), which apparently dates back to the earliest proponents of the use of prediction instruments. Lejins suggests that case

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[2] Correspondence dated April 14, 1967.

histories and other pertinent information available to the individual decision-maker should be used in combination with prediction tables in arriving at a decision. When this view is accepted, however, the question of how to use each source of information maximally arises. Prediction instruments do not make absolutely certain predictions, and they are plainly more reliable in predicting outcomes for some cases than they are for others. For example, when the prediction on an individual is 60 chances in 100 that he will successfully adjust, the prediction method has failed to make a discrimination very much better than could be accomplished by flipping a coin.

The development and refinement of prediction devices have focused on the problem of predictive discrimination. Attempts to refine the Glueck Social Prediction Table have concentrated on reducing the number of cases categorized as having approximately a 50-50 chance of becoming delinquent by finding ways to place them accurately in catego ies where the chances are either ten-to-one or one-in-ten of becoming delinquent (E.T. Glueck, 1962, 1963, 1966a, 1966b). Similarly, Glaser (1962) has sought to employ only those predictors in his tables which have discriminated parolees into a 43 per cent or a 77 per cent risk group.

Implications for the Present Project

The problems raised by the reviewed work imply guidelines for the present project which may be summarized in four areas.

1. Attempts to predict delinquency, parole adjustment, military suitability, and satisfactory duty from certain readily measured variables in an individual's background have yielded varying degrees of satisfactory results. The present stud attempts to capitalize on the availability of a large amount of background data coded on a particular population of delinquents in order to predict successful return to active duty in the Air Force.

2. The selection of background variables to enter as predictors in a mathematical analysis has often been unsatisfactorily accomplished by arbitrarily limiting consideration to a small number of variables of particular interest to a researcher, or by cumbersome and potentially misleading methods of tallying individual contingencies between possible predictor categories and a criterion. The present study attempts to overcome these limitations by making use of all available background data on a population by employing a high-speed digital computer and a routine for accomplishing multiple linear regression analysis on very large numbers of variables.

3. Summarizing the predictive capacity of several variables has been accomplished through various weighting procedures, not all of which derive optimum weights from the empirical data. The present study uses a regression analysis which accurately gauges the independent linear contribution of each predictor in a system.

4. Applying the results of prediction studies to actual decision problems has been an extremely uncertain step in the past because users have not known the extent to which prediction instruments should be used instead of or in conjunction with other decision-making procedures. The present work translates the mathematical analysis into a structured decision-making aid which indicates to the user the probable accuracy of each prediction made. In this regard it follows the lead of other research which has attempted to limit itself to predictions on only those cases where a clear and reliable distinction is likely.

III. PREDICTOR VARIABLES

Data on 139 variables were gathered on all retrainees referred to the Retraining Group since 1952. The sources of data included official write-ups of social history interviews, Retraining Team reports inserted at intervals during the retrainees' stay at the Retraining Group, Red Cross social investigations, and results of intelligence tests and personality inventories administered while the retrainees were assigned to the Retraining Group. Data were abstracted and punched in coded form onto cards; expansion of the 139 variables resulted in a total of 687 variables for analysis. A complete listing of the variables used and their construction is shown in Appendix II. The variables are listed according to the following categories:

1. Pre-Military Background
   a. General – early childhood, teenage years, family environment, sibling position, health, etc.
   b. Educational history
   c. Religious history
   d. Occupational history
   e. Free-time activities
   f. Marital history, age at marriage, attitude toward marriage, etc.
2. General Military Variables
   a. Base and command of referral
   b. Specialty aptitude scores, specialty assigned, skill level
   c. Enlistment data
3. Offense Variables
   a. Previous civilian and military offenses
   b. Present offense, age, indeptedness, etc.
   c. Trial for present offense
   d. Sentence from trial for present offense
4. Measurements while in Retraining Group

IV. PREDICTION CRITERION

There were three possible prediction criteria for the present study.

1. *Discharged from the Retraining Group.* This criterion applies when the Retraining Group does not return a man to duty but, rather, executes a punitive discharge sentenced by court-martial or administers a General, Undesirable, or Unsuitable Discharge as provided for under Air Force Manual 39-12.

2. *Returned to Duty – Success.* This criterion applies when a retrainee is returned to active duty by the Retraining Group and he succeeds in earning an Honorable Discharge at the end of his current enlistment.[3]

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[3] Air Force enlistments are in most cases of four years' duration. The average amount of time remaining on the enlistment of retrainees when they depart the Retraining Group is approximately two and one-half years.

3. *Returned to Duty—Failure.* This criterion applies when a retrainee is returned to active duty by the Retraining Group and he receives other than an Honorable Discharge prior to or at the end of his current enlistment.[4]

For the present study, criterion 2, Returned to Duty – Success, was selected. It was decided to study this criterion because it appeared the most likely to yield results of operational relevance.

V. SAMPLES

Two samples of the retrainee population were used: the first to develop the prediction model, and the second to accomplish an independent cross-validation.

Computation Sample

The computation sample ($N = 1,303$) was taken from the 6,799 retrainees passing through the Retraining Group from its founding in 1952 through the end of 1963. This group of 1,303 represented cases which had all requisite data and data which survived range-checking to catch erroneous recording and card-punching. (The major portion of cases not used lacked data entries for about two-thirds of the variables because an earlier data recording policy called for collection of certain data on only one out of ten retrainees.)

Cross-Validation Sample

The cross-validation sample ($N = 583$) was selected from the 664 retrainees who passed through the Retraining Group between January 1964 and June 1965. The cases included were those for which requisite data were complete and accurate as judged by range-checking. This cross-validation sample came from the retrainees of recent years during which the retraining program has been benefiting from the Air Force's higher enlistment standards and from the program's improved screening and treatment methods. It may, therefore, differ from the computation sample in some ways. Complete success-failure data are not yet available on retrainees of 1964 and 1965. However, the results of followup inquiries made six months after each retrainee in the cross-validation sample left the Retraining Group allow the comparison of end-of-enlistment data shown in Table 1. Six-month followup data have been shown in the past to be a reliable estimate of end-of-enlistment data. It appears from the table, then, that a pronounced shift has occurred in total population figures in the three categories; retrainees of the more recent years are being returned to duty at a higher rate and once back on duty are succeeding at a higher rate than retrainees of the earlier years of the program.

The apparent differences between the computation and cross-validation samples may arouse some skepticism regarding the possibility of deriving a valid prediction system. However, the probability that variables critical in predicting the criterion of interest would emerge seemed sufficient to justify this approach.

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[4] All discharges administered under authority other than Air Force Manual 39-10 are considered, for purposes here, as "other than honorable."

Table 1. **Comparison of End-of-Enlistment Data on Computation and Cross-Validation Samples**

End-of-Enlistment Criterion	Computation Sample	Cross-Validation Sample
Discharged from Retraining Group	47.4%	31.9%
Returned to Duty – Success	36.2%	60.2%
Returned to Duty – Failure	16.3%	7.8%

VI. ANALYSES

Two multiple regression analyses using the method developed by Bottenberg and Ward (1963) were carried out on the computation sample ($N = 1{,}303$). In the first analysis of 687 predictor variables, a regression equation was developed which would yield a prediction of the criterion Returned to Duty–Success. Using the entire computation sample, this criterion divided all cases into two groups: (*a*) those returned to duty who were successful, and (*b*) a pooled group consisting of those returned to duty who failed, plus those discharged from the Retraining Group. At the calculation time limit,[5] 61 predictor variables had entered the equation.

The second analysis was undertaken with the intention of building a system restricted to include only 13 variables selected from the 61 entering the first analysis. This second analysis was undertaken to calculate the optimum weights for a small number of predictors because such an equation, if found valid, would lend itself well to hand-calculated prediction and would not require that the user have access to computer facilities. The particular 13 variables used were selected for several reasons. These variables were among the first 16 to enter the equation produced in the first analysis, indicating that they assumed a major portion of the burden of prediction in that equation. Also, data on each of these variables are more easily and inexpensively obtained, and they lend themselves to more straightforward interpretation than do others. Finally, it was anticipated that a buildup of the predication composite would be possible in a system of 61 variables through capitalization on chance relationships in a computation sample, and that a system limited to a small subset of the available variables would not be as subject to this effect. In the second analysis the same sample and criterion were used as in the first analysis.

[5] The stop criterion employed was a 5 1/2-hour calculation time limit or failure of R^2 to increase by at least .00001 in succeeding iterations.

VII. RESULTS

Application of Prediction Equations to the Computation Sample

The present study was intended to demonstrate that a prediction instrument can be derived from the regression analysis of an almost unrestricted number of personal background variables for which data are easily obtained. Consequently, in reporting the results here, the predictive capacity of the multiple regression equations produced is the chief concern. The variables entering each equation, their individual validities with regard to the criterion, the order in which they entered the equation, and their regression weights are shown in Appendix III.

The first regression analysis resulted in an equation of 61 variables. The squared multiple correlation coefficient (R^2) for this equation was 0.318. The second analysis, which was based on 13 of the most predominant and easy-to-obtain variables emerging in the first analysis, yielded an R^2 of 0.183.

"Hits", or correct predictions of the criterion, were tallied applying each equation[6] to the segment of the computation sample which included only those retrainees who were returned to active duty (N 555). The tally was done on this restricted segment of the computation sample since it was reasoned that the analyses as carried out were likely to be more valid for this subgroup than for the unrestricted group. The results of these predictions are shown in Tables 2 and 3.

(Text continues on page 16)

[6] $P_i = \sum_{i=1}^{n} w_i v_i$, where P_i is a predicted score, w_i a regression weight, and v_i the value of a variable.

Table 2. **Hit Count Derived from Application of 61-Variable Prediction Equation to Restricted Segment of Computation Sample**

(N = 555, Returned Retrainees only)

Predicted Score Cutoff	Non-cumulative number at cutoff score	Number[a] Predicted Success Who Were Actual Success	Number[a] Predicted Success Who Were Actual Failure	Total[a] Predicted Success	Number[a] Predicted Failure Who Were Actual Success	Number[a] Predicted Failure Who Were Actual Failure	Total[a] Predicted Failure	Total Number[a] Correct Predictions
1.00	10	10	0	10	240	305	545	315
0.99	2	12	0	12	238	305	543	317
0.98	1	13	0	13	237	305	542	318
0.97	2	15	0	15	235	305	540	320
0.96	3	18	0	18	232	305	537	323
0.95	1	19	0	19	231	305	536	324
0.94	0	19	0	19	231	305	536	324
0.93	3	22	0	22	228	305	533	327
0.92	2	24	0	24	226	305	531	329
0.91	5	29	0	29	221	305	526	334
0.90	1	30	0	30	220	305	525	335
0.89	5	35	0	35	215	305	520	340
0.88	2	37	0	37	213	305	518	342
0.87	1	38	0	38	212	305	517	343
0.86	1	39	0	39	211	305	516	344
0.85	2	41	0	41	209	305	514	346
0.84	5	46	0	46	204	305	509	351
0.83	1	47	0	47	203	305	508	352
0.82	3	49	1	50	201	304	505	353
0.81	6	55	1	56	195	304	499	359
0.80	3	58	1	59	192	304	496	362
0.79	4	62	1	63	188	304	492	366
0.78	5	65	3	68	185	302	487	367
0.77	5	69	4	73	181	301	482	370
0.76	4	72	5	77	178	300	478	372
0.75	5	76	6	82	174	299	473	375
0.74	8	82	8	90	168	297	465	379
0.73	7	89	8	97	161	297	458	386
0.72	4	93	8	101	157	297	454	390
0.71	4	96	9	105	154	296	450	392
0.70	4	99	10	109	151	295	446	394
0.69	7	105	11	116	145	294	439	399
0.68	3	107	12	119	143	293	436	400
0.67	4	110	13	123	140	292	432	402
0.66	6	115	14	129	135	291	426	406
0.65	9	122	16	138	128	289	417	411
0.64	11	131	18	149	119	287	406	418
0.63	6	135	20	155	115	285	400	420
0.62	5	138	22	160	112	283	395	421
0.61	7	141	26	167	109	279	388	420
0.60	9	146	30	176	104	275	379	421
0.59	10	152	34	186	98	271	369	423
0.58	8	155	39	194	95	266	361	421
0.57	9	159	44	203	91	261	352	420
0.56	6	162	47	209	88	258	346	420
0.55	9	169	49	218	81	256	337	425
0.54	8	172	54	226	78	251	329	423
0.53	10	176	60	236	74	245	319	421
0.52	6	178	64	242	72	241	313	419
0.51	13	185	70	255	65	235	300	420
0.50	8	188	75	263	62	230	292	418

Table 2 *(Continued)*

Predicted Score Cutoff	Non-cumulative number at cutoff score	Number* Predicted Success Who Were Actual Success	Number* Predicted Success Who Were Actual Failure	Total* Predicted Success	Number* Predicted Failure Who Were Actual Success	Number* Predicted Failure Who Were Actual Failure	Total* Predicted Failure	Total Number* Correct Predictions
0.49	13	192	84	276	58	221	279	413
0.48	14	203	87	290	47	218	265	421
0.47	8	206	92	298	44	213	257	419
0.46	12	210	100	310	40	205	245	415
0.45	6	211	105	316	39	200	239	411
0.44	12	215	113	328	35	192	227	407
0.43	10	219	119	338	31	186	217	405
0.42	5	219	124	343	31	181	212	400
0.41	11	221	133	354	29	172	201	393
0.40	15	225	144	369	25	161	186	386
0.39	8	226	151	377	24	154	178	380
0.38	11	229	159	388	21	146	167	375
0.37	11	230	169	399	20	136	156	366
0.36	4	230	173	403	20	132	152	362
0.35	4	232	175	407	18	130	148	362
0.34	9	234	182	416	16	123	139	357
0.33	14	239	191	430	11	114	125	353
0.32	7	241	196	437	9	109	118	350
0.31	13	243	207	450	7	98	105	341
0.30	7	243	214	457	7	91	98	334
0.29	5	244	218	462	6	87	93	331
0.28	11	245	228	473	5	77	82	322
0.27	6	247	232	479	3	73	76	320
0.26	4	248	235	483	2	70	72	318
0.25	5	249	239	488	1	66	67	315
0.24	7	250	245	495	0	60	60	310
0.23	9	250	254	504	0	51	51	301
0.22	2	250	256	506	0	49	49	299
0.21	9	250	265	515	0	40	40	290
0.20	5	250	270	520	0	35	35	285
0.19	4	250	274	524	0	31	31	281
0.18	2	250	276	526	0	29	29	279
0.17	4	250	280	530	0	25	25	275
0.16	3	250	283	533	0	22	22	272
0.15	2	250	285	535	0	20	20	270
0.14	4	250	289	539	0	16	16	266
0.13	2	250	291	541	0	14	14	264
0.12	3	250	294	544	0	11	11	261
0.11	1	250	295	545	0	10	10	260
0.10	1	250	296	546	0	9	9	259
0.09	0	250	296	546	0	9	9	259
0.08	0	250	296	546	0	9	9	259
0.07	1	250	297	547	0	8	8	258
0.06	0	250	297	547	0	8	8	258
0.05	0	250	297	547	0	8	8	258
0.04	1	250	298	548	0	7	7	257
0.03	0	250	298	548	0	7	7	257
0.02	1	250	299	549	0	6	6	256
0.01	0	250	299	549	0	6	6	256
0.00	6	250	305	555	0	0	0	250

*Counts are cumulative.

Table 3. **Hit Count Derived from Application of 13-Variable Prediction Equation to Restricted Segment of Computation Sample**

(N = 555, Returned Retrainees only)

Predicted Score Cutoff	Non-cumulative number at cutoff Score	Number[a] Predicted Success Who Were Actual Success	Number[a] Predicted Success Who Were Actual Failure	Total[a] Predicted Success	Number[a] Predicted Failure Who Were Actual Success	Number[a] Predicted Failure Who Were Actual Failure	Total[a] Predicted Failure	Total Number[a] Correct Predictions
1.00	1	1	0	1	249	305	554	306
0.99	0	1	0	1	249	305	554	306
0.98	0	1	0	1	249	305	554	306
0.97	0	1	0	1	249	305	554	306
0.96	0	1	0	1	249	305	554	306
0.95	0	1	0	1	249	305	554	306
0.94	0	1	0	1	249	305	554	306
0.93	0	1	0	1	249	305	554	306
0.92	0	1	0	1	249	305	554	306
0.91	1	2	0	2	248	305	553	307
0.90	0	2	0	2	248	305	553	307
0.89	1	3	0	3	247	305	552	308
0.88	1	4	0	4	246	305	551	309
0.87	3	7	0	7	243	305	548	312
0.86	2	9	0	9	241	305	546	314
0.85	2	11	0	11	239	305	544	316
0.84	0	11	0	11	239	305	544	316
0.83	0	11	0	11	239	305	544	316
0.82	1	12	0	12	238	305	543	317
0.81	1	13	0	13	237	305	542	318
0.80	2	15	0	15	235	305	540	320
0.79	2	17	0	17	233	305	538	322
0.78	1	17	1	18	233	304	537	321
0.77	4	21	1	22	229	304	533	325
0.76	4	25	1	26	225	304	529	329
0.75	4	29	1	30	221	304	525	333
0.74	2	30	2	32	220	303	523	333
0.73	4	34	2	36	216	303	519	337
0.72	3	35	4	39	215	301	516	336
0.71	3	38	4	42	212	301	513	339
0.70	4	42	4	46	208	301	509	343
0.69	2	44	4	48	206	301	507	345
0.68	1	45	4	49	205	301	506	346
0.67	7	51	5	56	199	300	499	351
0.66	6	56	6	62	194	299	493	355
0.65	11	64	9	73	186	296	482	360
0.64	5	66	12	78	184	293	477	359
0.63	6	71	13	84	179	292	471	363
0.62	3	73	14	87	177	291	468	364
0.61	6	79	14	93	171	291	462	370
0.60	9	84	18	102	166	287	453	371
0.59	8	92	18	110	158	287	445	379
0.58	10	100	20	120	150	285	435	385
0.57	9	106	23	129	144	282	426	388
0.56	12	112	29	141	138	276	414	388
0.55	9	117	33	150	133	272	405	389
0.54	21	125	46	171	125	259	384	384
0.53	14	130	55	185	120	250	370	380
0.52	14	137	62	199	113	243	356	380
0.51	13	142	70	212	108	235	343	377
0.50	6	144	74	218	106	231	337	375

Table 3 *(Continued)*

Predicted Score Cutoff	Non-cumulative number at cutoff Score	Number[a] Predicted Success Who Were Actual Success	Number[a] Predicted Success Who Were Actual Failure	Total[a] Predicted Success	Number[a] Predicted Failure Who Were Actual Success	Number[a] Predicted Failure Who Were Actual Failure	Total[a] Predicted Failure	Total Number Correct Predictions[a]
0.49	9	149	78	227	101	227	328	376
0.48	14	157	84	241	93	221	314	378
0.47	17	167	91	258	83	214	297	381
0.46	16	175	99	274	75	206	281	381
0.45	13	183	104	287	67	201	268	384
0.44	13	187	113	300	63	192	255	379
0.43	7	189	118	307	61	187	248	376
0.42	12	196	123	319	54	182	236	378
0.41	17	200	136	336	50	169	219	369
0.40	17	205	148	353	45	157	202	362
0.39	11	208	156	364	42	149	191	357
0.38	23	213	174	387	37	131	168	344
0.37	11	216	182	398	34	123	157	339
0.36	7	221	184	405	29	121	150	342
0.35	15	223	197	420	27	108	135	331
0.34	12	225	207	432	25	98	123	323
0.33	13	228	217	445	22	88	110	316
0.32	3	228	220	448	22	85	107	313
0.31	9	230	227	457	20	78	98	308
0.30	8	232	233	465	18	72	90	304
0.29	8	233	240	473	17	65	82	298
0.28	6	235	244	479	15	61	76	296
0.27	8	238	249	487	12	56	68	294
0.26	7	242	252	494	8	53	61	295
0.25	13	245	262	507	5	43	48	288
0.24	6	245	268	513	5	37	42	282
0.23	3	245	271	516	5	34	39	279
0.22	5	246	275	521	4	30	34	276
0.21	3	246	278	524	4	27	31	273
0.20	2	246	280	526	4	25	29	271
0.19	3	246	283	529	4	22	26	268
0.18	4	246	287	533	4	18	22	264
0.17	4	248	289	537	2	16	18	264
0.16	2	249	290	539	1	15	16	264
0.15	5	249	295	544	1	10	11	259
0.14	1	249	296	545	1	9	10	258
0.13	3	249	299	548	1	6	7	255
0.12	1	249	300	549	1	5	6	254
0.11	1	249	301	550	1	4	5	253
0.10	0	249	301	550	1	4	5	253
0.09	1	249	302	551	1	3	4	252
0.08	1	249	303	552	1	2	3	251
0.07	1	250	303	553	0	2	2	252
0.06	0	250	303	553	0	2	2	252
0.05	0	250	303	553	0	2	2	252
0.04	1	250	304	554	0	1	1	251
0.03	0	250	304	554	0	1	1	251
0.02	0	250	304	554	0	1	1	251
0.01	1	250	305	555	0	0	0	250
0.00	0	250	305	555	0	0	0	250

[a] Counts are cumulative.

Interpretation of the Hit Tables

In Tables 2 and 3 a range of predicted scores from 0.00 through 1.00 is shown in the left-most column. Criterion values are calculated by applying a regression equation to each case in the sample of retrainees. In general, it is reasonable to expect that the closer the predicted criterion value is to 0.00, the more likely the individual is a failure case. Conversely, the closer the predicted value is to 1.00, the greater the likelihood that the individual is a success case. The values between these two extremes – and, of course, most of the cases fall in between – can be interpreted either way. That is, the reader must use the rest of the table to arrive at a cutoff level above which all predicted scores are interpreted as successes and below which all are interpreted as failures. For example, at a cutoff level of 0.5 in Table 2 (reading across the table), 263 cases at that level and above were predicted successes, 188 of which were actual successes; 292 cases at that level and below were predicted failures, 230 of which were actual failures; and in all, 418 were correctly predicted (both successes and failures). The right-most column gives an indication of the cutoff level which would maximize correct decisions, in this case 0.55, which yielded 425 correct predictions.

Inspection of the right-most columns, Total Number Correct Predictions, of Tables 2 and 3 indicates encouragingly high retrospective predictions with both equations. Table 2 shows that application of the 61-predictor system to the restricted sample (retrainees returned to duty only) produced 425 correct predictions out of a possible 555 at an optimal score cutoff of 0.55. Finally, Table 3 indicates that the 13-predictor system applied to the restricted sample produced 389 correct classifications out of 555, also at an optimal cutoff of 0.55.

Comparison of the results in Tables 2 and 3 indicates that the larger regression system (61 predictors) successfully classified 36, or 6.5 per cent, more of the cases in the restricted segment of the computation sample than did the smaller system (13 predictors). This is consistent with the difference in multiple R^2 values for the two systems. However, the larger system might be providing greater predictive efficiency by capitalizing on chance relationships among the variables. In this event, the smaller system might prove more accurate when applied to a different sample of cases.

A fairly enthusiastic overall evaluation of this initial hit count must be coupled with the mention of a significant shortcoming. If either regression system had been available for use when decisions were made regarding the 555 retrainees, fewer men who would subsequently fail would have been returned to duty. At the same time, if all cases with predicted scores below the optimizing cutoff had been discharged rather than returned to active duty, some potentially successful retrainees would have been among those discharged.

It is apparent, then, that a way must be found to minimize this waste of potentially successful personnel. While the maximum number of accurate predictions occurred at a score just above 0.50, as shown by Tables 2 and 3, there was a large number of incorrect predictions in this middle range as well. Among the scores at the low end and at the high end, however, there were fewer erroneous predictions. Thus, the usefulness of both regression equations is considerably greater within predicted score ranges of, say, 0.00 through 0.45 and 0.65 through 1.00. The middle range of predicted scores (approximately 0.46 through 0.64) seems less useful because neither regression system is able to make consistently accurate distinctions in that range.

Application of Prediction Equations to the Cross-Validation Sample

The foregoing findings seem to argue against applying the regression equations in the same way to the cross-validation sample with its 583 new cases. Instead, a more realistic field test of a probable application might require identifying two new predicted score cutoffs, one somewhat below the optimizing cutoff level used before and one somewhat above that optimizing cutoff.

For the 61-predictor system an upper cutoff of 0.63 and a lower cutoff of 0.45 were established by inspection of the hit table. Corresponding cutoffs for the 13-predictor system were 0.65 and 0.45. This means that predictions were made only on those cases with predicted scores below 0.45 and above 0.63 and 0.65 (with application of the larger and smaller regression systems, respectively). This cross-validation, then, evaluated each of the systems according to how many retrainees with scores below 0.45 actually become failures and how many with scores above 0.63 or 0.65 actually were successes. (Predictions for those receiving scores between these two cutoff levels were not made.)

At this time, complete end-of-enlistment followup data are not available for the cross-validation sample; therefore, a comprehensive cross-validation on this sample is not possible. However, among the 583 cases in the cross-validation sample, 397 retrainees were returned to duty; of these 397, final criterion values were available for 138 cases. Tables 4 and 5 show the results of predictions on this sample.

Table 4. **Results Obtained from Application of 61-Variable Prediction Equation to Restricted Segment of Cross-Validation Sample**

(N = 138, Returned Retrainees only)

Predicted Score Range	Number in Interval	Predicted Success Who Were Actual Success		Predicted Success Who Were Actual Failure		Predicted Failure Who Were Actual Success		Predicted Failure Who Were Actual Failure	
		N	%	N	%	N	%	N	%
0.63 & above	31	21	67.7	10	32.3	-	-	-	-
0.45 & below	63	-	-	-	-	26	41.3	37	58.7

Table 5. **Results Obtained from Application of 13-Variable Prediction Equation to Restricted Segment of Cross-Validation Sample**

(N = 138, Returned Retrainees only)

Predicted Score Range	Number in Interval	Predicted Success Who Were Actual Success		Predicted Success Who Were Actual Failure		Predicted Failure Who Were Actual Success		Predicted Failure Who Were Actual Success	
		N	%	N	%	N	%	N	%
0.65 & above	31	24	77.4	7	22.6	-	-	-	-
0.45 & below	40	-	-	-	-	11	27.5	29	72.5

The results obtained when the 61-variable system was applied to the cross-validation sample are shown in Table 4. Of the 138 cases on whom records were complete, 31 had predicted scores at or above the upper cutoff. Of these 31 cases, 21 succeeded and 10 failed. There were 63 predicted scores at or below the lower cutoff. Of these 63 cases, 37 failed and 26 succeeded. (The remaining 44 cases had predicted scores neither above the upper cutoff nor below the lower cutoff and, therefore, were not classified.) Thus, the 61-predictor system was 67.7 per cent accurate in predicting successes and 58.7 per cent accurate in predicting failures; its overall accuracy was 61.7 per cent.

The results obtained when the 13-predictor system was applied to the cross-validation sample are shown in Table 5. There were 31 cases with predicted scores at or above the upper cutoff; of these, 24 succeeded and 7 failed. There were 40 predicted scores at or below the lower cutoff; of these, 11 succeeded and 29 failed. (Again, the 67 remaining cases were not classified because the prediction system yielded a score between the designated cutoffs.) Thus, the 13-predictor system was accurate in predicting successes 77.4 per cent of the time and accurate in predicting failures 72.5 per cent of the time; the overall accuracy was 74.6 per cent.

It is necessary to compare the prediction accuracy in classifying successes *vs.* failures for both systems. It is quite possible for a prediction system, for example, to be usefully accurate in predicting failures but too inaccurate in predicting successes to be useful. From the results shown in Tables 4 and 5, it seems apparent that both systems are somewhat better at predicting successes than at predicting failures but are encouragingly accurate at both.

Finally, the superiority of one system over the other must be considered. According to the percentages based on the first 138 cross-validation cases on which criterion data have been received, the 13-predictor system is apparently superior in all categories.

VIII. IMPLICATIONS FOR FURTHER WORK

The work reported in this paper is felt to be a sound beginning in the development of a prediction system for use as an aid to decisions regarding the return of retrainees to active duty. The value of this project will be fully realized, however, only if the experiences and accomplishments it has produced are built upon. Several areas for further work are indicated.

1. *Refining Regression Systems.* Continuing refinements of the multiple regression prediction instruments should be undertaken. This should be accomplished in part by introducing new predictor variables into the analysis. These might include interaction variables constructed from individual variables already in the analysis; new variables coded from behavior and performance measured or observed while retrainees are involved in the Retraining Group program (which would answer the criticism that predictions are being made only from static variables of the individual's past); and new variables defined according to suggestions from the work of other investigators who have explored prediction of delinquency and recidivism.

Toward further refinement, additional regression analyses should be computed to discover the most stable and powerful combination of variables for prediction purposes.

2. *Systematizing Procedures for Updating and Refining Prediction Systems.* The procedures for refining the prediction instruments should be reduced to the simplest possible sequence so that a continuing program of refinements and cross-validations on recent populations can be accomplished with a minimum of confusion and reaccomplishment of cards, tapes, intercorrelation matrices, etc.

3. *Defining Procedures for Evaluating the Validity of a Prediction System.* In view of the discussions (see Appendix I) of how prediction systems can be employed to take systematically into account their demonstrated validity, procedures should be carefully defined for evaluating the state of a prediction system's validity and expressing that evaluation in terms such as high and low cutoff levels.

4. *Determining Applicability of Variables to Prediction of Delinquency in Broader Populations.* Once a convincing case has been made for the predictive validity of one or more variables and, perhaps, for their causal relationship to rehabilitation success, the question arises as to whether the same variables are also related to delinquent behavior in general. That is, do the same variables which effectively predict successful and unsuccessful rehabilitation of delinquents also predict the occurrence and nonoccurrence of delinquent behavior in the broad population of people not yet convicted of delinquent offenses? To answer this question, data on the 13 variables found useful here could be collected on a sample of Air Force enlistees as they pass through basic training; then predictions could be made using the 13-predictor regression equation with a cross-validation performed on criterion (offense *vs.* nonoffense) data collected during the four years of active duty following basic training. If such a system proved as capable of predicting delinquent offenses in this population as it appears to be in predicting return-to-duty success among retrainees, it could be reasonably concluded that the 13 variables currently in question are related to delinquency in general.

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APPENDIX I: APPLICATIONS OF A PREDICTION SYSTEM

The results of the simulated application of the regression systems to the cross-validation sample reported here represent an encouraging cross-validation on new cases. The manner in which that cross-validation was carried out suggests a model for operational application of one or both of the regression systems if the criterion data yet to be collected on the cross-validation sample further confirm the validity indicated so far.

The procedure used in the cross-validation has enough flexibility to permit response to accuracies and inaccuracies discovered as the cross-validation continues. For example, if very high accuracy is experienced using the cutoff levels of 0.65 and 0.45, such that more erroneous judgments could be tolerated, one or both of the cutoff levels could be moved toward 0.50. By doing this, useful predictions could be generated on a larger portion of the cases. Likewise, the experience of excessively low accuracy could be responded to by raising the upper cutoff and/or lowering the lower one, recognizing the system's inability to discriminate accurately except on the extreme scores.

A Recommended Operational Application

The following paragraphs outline a proposed application of a multiple regression prediction system at the Retraining Group. Such intervention of a mathematical system into the operational decision processes of the Retraining Group, of course, would be justified only if the cross-validation demonstrates adequate accuracy.

At the Retraining Group, recommendations regarding eventual discharge or return to duty are developed on each individual retrainee by Retraining Teams. A three-member Final Classification Board then meets to consider such recommendations and, in turn, to make recommendations for their adoption or rejection to the Retraining Group Commander. The Retraining Group Commander reviews the action of the Final Classification Board while taking into consideration all other factors and information he deems pertinent and then makes his recommendations to the Training Center Commander for final disposition. It is suggested that the multiple regression prediction system be introduced as a source of information and a decision aid at the level of the Retraining Group Commander.

In this proposed application, the predictions of the regression system would be provided to the Retraining Group Commander only when the decision makers (e.g., members of the Final Classification Board) and the regression system disagree, and then only when the predicted score from the regression system is within the system's range of "competence" (i.e., above or below the determined cutoff levels). In this manner, the Commander would be alerted to reconsider cases which the Final Board has recommended for return to active duty but for which the regression system predicts failure, and cases which the Final Board has recommended for discharge but for which the regression system predicts success if returned to duty.[7]

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[7] It must be noted that this second category of assistance goes beyond the validity of the prediction instrument demonstrated in the cross-validation. That is, the cross-validation necessarily considers only those cases actually returned to duty; no data exist on the validity of predictions regarding those retrainees discharged from the Retraining Group. However, it would seem reasonable to hypothesize that a system valid in predicting success or failure among those for whom a tentative decision to return to duty has been made might also be valid for cases on whom a tentative decision to discharge has been made. A test of this hypothesis is possible through applying the prediction instrument to cases recommended for discharge, as described here.

To aid the Commander in reconsidering the cases called to his attention by this process, he would be supplied tables based on the most recent cross-validation results indicating what happened (success or failure) to approximately 50 to 55 retrainees sent back to duty who had predicted scores closest to the value of the retrainee in question. (Such a table would indicate the rate of success of the 50 to 55 retrainees sent back to duty who had predicted scores the same as or 0.02 to 0.03 points either side of the score in question. Appendix IV shows a sample of such a table, how it is computed, and how it can be used.) This should enable the Commander to use most effectively the predicted score for the retrainees on which the regression system intervenes in order to decide when to concur or not to concur with the recommendation of the Final Board. Use of a regression system in this manner should enable the Retraining Group to increase the proportion of those who succeed when sent back to duty.

Other Ways to Apply the Prediction System

The described procedure for employing operationally a regression system in the decision processes of the Retraining Group is considered by the authors to be the most promising. However, the following applications indicate some possible variations in the use of mathematical predictions in a structured decision process performed primarily by individuals.[8]

1. Computed predicted scores could be used to divide candidates into three "zones." Predictions in the zones shown by previous cross-validation to be highly accurate would not be reviewed. An individual decision maker would review the zone or zones where previous cross-validations indicate the mathematical prediction system to be least accurate. Where the individual and the system agree, the decision would be ratified; on those cases where the individual and the system disagree, referral would be made for final decision by a three-member board. Alternatively, the three-member board could be routinely convened for all cases in a zone where the mathematical system is consistently unable to discriminate.

2. The prediction system could be used to compute a predicted score for all cases. An individual evaluator would also review the cases with knowledge of the predicted score for each. Those cases for which the computed predicted score is considered too high or too low would be referred to a three-member board.

3. Both the computerized prediction system and an individual decision maker could assign predicted scores to all cases. These scores would be arrived at independently, then compared by a second evaluator. Cases with a discrepancy larger than a predetermined size (determined by the known accuracy of the mathematical prediction system) would be reviewed by a three-member board.

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[8] These alternative procedures were derived from suggestions made by E.C. Tupes of the Personnel Research Laboratory. These applications indicate ways of introducing a prediction system at the classification board level and thereby offering to increase accuracy while reducing the number of officer-hours involved in decision-making.

APPENDIX II: VARIABLES USED TO DERIVE PREDICTION SYSTEMS

The 687 dichotomous and continuous variables used to derive the 61-variable and the 13-variable prediction systems are presented. Dichotomous variables assume the value of 1 where the conditions specified are true and 0 otherwise. Continuous variables assume an integer value as indicated.

The variables are classified according to the following categories

1. Pre-Military Background Variables
    a. General, Family Environment, etc.
    b. Educational History
    c. Religious History
    d. Occupational History
    e. Free-Time Activities
    f. Marital History, Age at Marriage, Attitude, etc.
2. General Military Variables
    a. Air Force Base and Command of Referral
    b. Specialty Aptitude Score, Specialty Assigned, Skill Level
    c. Enlistment and Rank Data
3. Offense Variables
    a. Previous Civilian and Military Offenses, Sentences, etc.
    b. Present Offense
    c. Court-Martial for Present Offense
    d. Sentence from Present Court-Martial
4. Measurements while in Retraining Group
5. Criteria

Appendix II (*Continued*)

Variable Number	Integer Value	Variable by Classification Category
		1. Pre-Military Background Variables
		a. General, Family Environment, etc.
98	Continuous	Age at arrival (nearest year)
98	Continuous	Year of birth
		If race is
100	1	Caucasian
101	1	Negro
102	1	Indian
103	1	Oriental
104	1	Other
105	1	Not recorded
159	Continuous	Number of brothers during formative years
185	Continuous	Number of sisters during formative years
		If criminality among immediate members of family is
163	1	Yes
164	1	No
165	1	Not recorded
		If retrainee's evaluation of economic standard of his home is
166	1	Above average
167	1	Average
168	1	Below average
158	1	Not recorded
		If alcohol used frequently by any member of family is
169	1	Yes
170	1	No
171	1	Not recorded
		If truancy from school is
172	1	Yes
173	1	No
174	1	Not recorded
		If marital status of parents is
175	1	Married, never divorced
176	1	Married, reconciled
177	1	Separated
178	1	Divorced
179	1	Divorced, remarried
180	1	Separated by death
181	1	Both parents deceased
182	1	Unknown
183	1	Other
184	1	Not recorded

Appendix II (*Continued*)

Variable Number	Integer Value	Variable by Classification Category
		If father's or breadwinner's occupation is
186	1	Professional
187	1	Semiprofessional
188	1	Clerical
189	1	Farmer
190	1	Semiskilled
191	1	Slightly skilled
192	1	Day laborer
193	1	Not recorded
194	1	Other
195	1	Unknown
		If residence during childhood is
160	1	Northeast: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Washington, D.C.
196	1	Southwest: Arizona, New Mexico, Oklahoma, Texas
197	1	Middle States: Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, West Virginia, Wisconsin
198	1	Southeast: Alabama, Arkansas, Florida, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, Georgia
199	1	Northwest: Alaska, Colorado, Idaho, Kansas, Montana, Nebraska, North Dakota, South Dakota, Utah, Wyoming
200	1	Far West: Nevada, Oregon, Washington, Hawaii, California
245	1	Not USA
246	1	Not recorded
207	Continuous	Number of previous civilian offenses
		If primary type of civilian offense is
208	1	Not recorded
209	1	None committed
210	1	Dishonesty or fraud
211	1	Sex
212	1	Violence, assaultive
213	1	Drunken Driving
214	1	Driving, minor infraction
215	1	Disorderly conduct
216	1	Other

Appendix II (*Continued*)

Variable Number	Integer Value	Variable by Classification Category
		If secondary type of civilian offense is
217	1	Not recorded
218	1	No offenses on record
219	1	Dishonesty or fraud
220	1	Sex
221	1	Violence, assaultive
222	1	Drunken driving
223	1	Driving, minor infraction
224	1	Disorderly conduct
225	1	Other
		If sibling position is
298	1	Oldest third of female siblings
299	1	Middle third of female siblings
300	1	Youngest third of female siblings
301	1	Oldest third of male siblings
302	1	Middle third of male siblings
303	1	Youngest third of male siblings
304	1	Oldest third of mixed siblings
305	1	Middle third of mixed siblings
306	1	Youngest third of mixed siblings
307	1	Only child
308	1	Indeterminate, some siblings
309	1	Not recorded
		If father's physical health through retrainee's 7th year is
310	1	No, or almost no, illnesses
311	1	Minor illnesses, occasional
312	1	Continual minor illnesses
313	1	1 major illness or serious accident
314	1	More than 1 major illness
315	1	Disabled for less than 1 year
316	1	Disabled for more than 1 year
317	1	No father during majority of period
318	1	Not recorded
		If father's physical health from retrainee's 8th through 18th year is
319	1	No, or almost no, illnesses
320	1	Minor illnesses, occasional
321	1	Continual minor illnesses
322	1	1 major illness or serious accident
323	1	More than 1 major illness
324	1	Disabled for less than 1 year
325	1	Disabled for more than 1 year
326	1	No father during majority of period
327	1	Not recorded

Variable Number	Integer Value	Variable by Classification Category
		If mother's physical health through retrainee's 7th year is
328	1	No, or almost no, illnesses
329	1	Minor illnesses, occasional
330	1	Continual minor illnesses
331	1	1 major illness or serious accident
332	1	More than 1 major illness
333	1	Disabled for less than 1 year
334	1	Disabled for more than 1 year
335	1	No mother during majority of period
336	1	Not recorded
		If mother's physical health from retrainee's 8th through 18th year is
337	1	No, or almost no, illnesses
338	1	Minor illnesses, occasional
339	1	Continual minor illnesses
340	1	1 major illness or serious accident
341	1	More than 1 major illness
342	1	Disabled for less than 1 year
343	1	Disabled for more than 1 year
344	1	No mother during majority of period
345	1	Not recorded
		If mother's occupation is
346	1	Professional
347	1	Semiprofessional
348	1	Clerical
349	1	Farmer
350	1	Semiskilled
351	1	Slightly skilled
352	1	Day laborer
353	1	Did not work
354	1	Not recorded
		If any periods of absence of 3 months or longer of 1 parent during retrainee's first 7 years is
355	1	No
356	1	Yes
357	1	Multiple short absences
358	1	Not recorded
		If any periods of absence of 3 months or longer of 1 parent from 8th through 11th years is
359	1	No
360	1	Yes
361	1	Multiple short absences
362	1	Not recorded

Appendix II (*Continued*)

Variable Number	Integer Value	Variable by Classification Category
		If any periods of absence of 3 months or longer of 1 parent from 12th through 15th year is
363	1	No
364	1	Yes
365	1	Multiple short absences
366	1	Not recorded
		If any periods of 1 year or longer in
367	1	Foster homes
368	1	Orphanages
369	1	Other noncorrectional institutions
370	1	Relatives' homes
371	1	Reform school or other correctional institution
372	1	Boarding schools
373	1	None
		If type of environment during childhood is
374	1	Rural (does not live near town; may live near village)
375	1	Semi-rural (lives in village or near larger town)
376	1	Small town (2,500 to 10,000)
377	1	Semi-urban (10,000 to 25,000)
378	1	Urban (25,000 to 200,000)
379	1	Super-urban (200,000 to 1,000,000)
380	1	Super-duper-urban (over 1,000,000)
381	1	Not recorded
		If mobility of retrainee and natural parents
382	1	Did not live with natural parents
383	1	Did not move
384	1	Moved 1 time
385	1	Moved 2 or 3 times
386	1	Moved 4 – 6 times
387	1	Moved 7 – 10 times
388	1	Moved 11 or more times
389	1	Not recorded
		If number of foster or relatives' homes lived in
390	1	Lived with natural parents
391	1	1 home
392	1	2 homes
393	1	3 – 4 homes
394	1	5 – 7 homes
395	1	Over 7 homes
396	1	Not recorded

Appendix II (*Continued*)

Variable Number	Integer Value	Variable by Classification Category
		If age during which lived away from natural home is
397	1	1 – 7 years
398	1	1 – 11 years
399	1	1 – 15 years and older
400	1	7 – 11 years
401	1	7 – 15 years and older
402	1	12 – 15 years and older
403	1	Lived with natural parents
404	1	Not recorded
		If age at parents' divorce or separation is
405	1	Not divorced or separated
406	1	16 years and older
407	1	12 – 15 years
408	1	8 – 11 years
409	1	4 – 7 years
410	1	Below 4 years
411	1	Not recorded
		If age at father's or mother's death is
412	1	20 years and older
413	1	19 - 18 years
414	1	17 years
415	1	16 years
416	1	15 years
417	1	14 years
418	1	13 years
419	1	12 years
420	1	11 years
421	1	10 years
422	1	9 years
423	1	8 years
424	1	7 years
425	1	6 years
426	1	5 years
427	1	4 years
428	1	3 years
429	1	2 years
430	1	1 year
431	1	Both living
432	1	Not recorded

Appendix II (*Continued*)

Variable Number	Integer Value	Variable by Classification Category
		If primary branch of military father served in is
433	1	Army
434	1	Navy
435	1	Marines
436	1	Air Force
437	1	Coast Guard, Seabees
438	1	Some military, branch undetermined
439	1	No father
440	1	No military
441	1	Not recorded
		If highest rank attained by father is
442	1	E-1, E-2, E-3
443	1	E-4, E-5
444	1	E-6 (TSgt)
445	1	E-7, E-8, E-9 (MSgt, SMSgt, CMSgt)
446	1	W-1, W-2, W-3, W-4 (Warrant Officer)
447	1	2d Lt, 1st Lt, Captain
448	1	Major and higher
449	1	No military service
450	1	Not recorded
		If duration of father's military service is
451	1	Less than 2 years
452	1	2 – 4 years
453	1	5 – 8 years
454	1	8 – 12 years
455	1	Over 12 years
456	1	No military service
457	1	Not recorded
		If retrainee's physical health through first 7 years is
458	1	No, or almost no, illnesses
459	1	Minor illnesses, occasional
460	1	Continual minor illnesses
461	1	1 major illness or serious accident
462	1	More than 1 major illness
463	1	Disabled for less than 1 year
464	1	Disabled for more than 1 year
465	1	Not recorded

Variable Number	Integer Value	Variable by Classification Category
		If retrainee's physical health from 8th year is
466	1	No, or almost no, illnesses
467	1	Minor illnesses, occasional
468	1	Continual minor illnesses
469	1	1 major illness or serious accident
470	1	More than 1 major illness
471	1	Disabled for less than 1 year
472	1	Disabled for more than 1 year
473	1	Not recorded
		If height of retrainee is
474	1	76 inches or above
475	1	75, 74 inches
476	1	73, 72 inches
477	1	71, 70 inches
478	1	69, 68 inches
479	1	67, 66 inches
480	1	65, 64 inches
481	1	Below 64 inches
482	1	Not recorded
		If drinking habits of retrainee is
646	1	Never
647	1	Seldom
648	1	Occasionally
649	1	Frequently
650	1	Habitually
651	1	Not recorded
		If any use of narcotics is
652	1	Yes
653	1	Not recorded

1. Pre-Military Background Variables
b. Educational History

68	Continuous	Years of education
		If general educational development certificate received prior to arrival at Retraining Group is
69	1	Yes
70	1	No
71	1	Not necessary (i.e., high school graduate)

Appendix II (*Continued*)

Variable Number	Integer Value	Variable by Classification Category
162	Continuous	Number of times failed in school
		If truancy from school is
172	1	Yes
173	1	No
174	1	Not recorded
		If age at leaving school is
483	1	21 years or older
484	1	20, 19 years
485	1	18 years
486	1	17 years
487	1	16 years
488	1	15 years
489	1	14 years
490	1	13 years or below
491	1	Not recorded
		If number of grades failed or grades in which majority of courses were failed is
492	1	0
493	1	1
494	1	2
495	1	3
496	1	4 or more
497	1	Not recorded
		If grades failed are
498	1	1 – 3
499	1	4 – 6
500	1	7 – 9
501	1	10 – 12
502	1	College
503	1	No failures
504	1	Not recorded
		If best subject was
505	1	Mathematics
506	1	Social Sciences
507	1	English
508	1	Art and Music
509	1	Shop courses
510	1	Science and Physical Sciences
511	1	Other
512	1	No favorites
513	1	Not recorded

Variable Number	Integer Value	Variable by Classification Category
		If worst subject was
514	1	Mathematics
515	1	Social Sciences
516	1	English
517	1	Art and Music
518	1	Shop courses
519	1	Sciences and Physical Sciences
520	1	Other
521	1	No worst subjects
522	1	Not recorded
		If retrainee's attitude toward teachers is
523	1	Positive
524	1	Neutral
525	1	Negative
526	1	Not recorded
		If retrainee's average grades during high school were
527	1	A's
528	1	B's
529	1	C's
530	1	Below average
531	1	Failing
532	1	No high school
533	1	Not recorded
		If retrainee's average grades during elementary and junior high school were
534	1	A's
535	1	B's
536	1	C's
537	1	Below average
538	1	Failing
539	1	Not recorded

1. Pre-Military Background Variables
c. Religious History

		If religious preference is
106	1	Catholic, Roman or Greek Orthodox
107	1	Protestant: No denomination, Baptist, Methodist, Lutheran, Presbyterian, Episcopal, Church of Christ, Nazarene, United Brethren, Assembly of God, Church of God, Christian, Pentecostal, Holiness, Seventh Day Adventists, Christian Scientist, Congregational, Evangelical Reformed, Jehovah's Witnesses
108	1	Morman (LDS)
109	1	Hebrew (Jewish)
110	1	Agnostic, Atheist, None claimed, other
111	1	Not recorded

Appendix II (*Continued*)

Variable Number	Integer Value	Variable by Calssification Category
		1. Pre-Military Background Variables
		d. Occupational History
		If number of civilian part-time jobs is
554	1	4 or more
555	1	3
556	1	2
557	1	1
558	1	0
559	1	Not recorded
		If number of civilian full-time jobs is
560	1	4 or more
561	1	3
562	1	2
563	1	1
564	1	0
565	1	Not recorded
		If primary type of civilian work is
566	1	Professional
567	1	Semiprofessional
568	1	Clerical
569	1	Farmer
570	1	Semiskilled
571	[illegible]	Slightly skilled
572	1	Day laborer
573	1	Not recorded
574	1	Did not work
		1. Pre-Military Background Variables
		e. Free-Time Activities
		If participated in
540	1	Football
541	1	Boxing
542	1	Football and boxing
543	1	None
544	1	Not recorded

Variable Number	Integer Value	Variable by Classification Category
		If other sports participated in
545	1	Baseball
546	1	Basketball
547	1	Track
548	1	Swimming
549	1	Other, team
550	1	Other, individual
551	1	2 or more of the above
552	1	None
553	1	Not recorded

1. Pre-Military Background Variables
f. Marital History

Variable Number	Integer Value	Variable by Classification Category
		If retrainee's marital status is
112	1	Single
113	1	Married
114	1	Divorced
115	1	Widowed
116	1	Not recorded
117	Continuous	Number of dependents
		If number of times engaged is
575	1	0
576	1	1
577	1	2
578	1	3 or more
579	1	Not recorded
		If pre-marital sex is
580	1	Frequent
581	1	Occasional
582	1	Seldom
583	1	Never
584	1	Had relations, frequency undetermined
585	1	Not recorded
		If marital history is
586	1	Never married
587	1	Married, 1st marriage
588	1	Married, 2d marriage
589	1	Married, 3d marriage
590	1	Unmarried, 1 previous marriage
591	1	Unmarried, 2 previous marriages
592	1	Separated
593	1	Other
594	1	Not recorded

Appendix II (*Continued*)

Variable Number	Integer Value	Variable by Classification Category
		If retrainee's age at marriage is
595	1	21 years and older
596	1	20 years
597	1	19 years
598	1	18 years
599	1	17 years
600	1	16 years
601	1	15 years or below
602	1	Not married
603	1	Not recorded
		If wife's age at marriage is
604	1	21 years and older
605	1	20 years
606	1	19 years
607	1	18 years
608	1	17 years
609	1	16 years
610	1	15 years or below
611	1	Retrainee not married
612	1	Not recorded
		If forced wedding is
613	1	No
614	1	Yes
615	1	Not married
616	1	Not recorded
		If length of retrainee's marriage at time of offense is
617	1	5 years or longer
618	1	4 years
619	1	3 years
620	1	2 years
621	1	1 year
622	1	6 months to 1 year
623	1	Less than 6 months
624	1	Not married
625	1	Not recorded
		If retrainee's parents' attitude toward retrainee's marriage is
626	1	Positive
627	1	Neutral
628	1	Negative
629	1	Retrainee not married
630	1	Not recorded

Variable Number	Integer Value	Variable by Classification Category
		If wife's parents' attitude toward marriage to retrainee is
631	1	Positive
632	1	Neutral
633	1	Negative
634	1	Retrainee not married
635	1	Not recorded
		If success of retrainee's marriage is
636	1	Successful
637	1	Neutral
638	1	Unsuccessful, separation contemplated or completed
639	1	Not married
640	1	Not recorded
		If separated from wife at time of offense is
641	1	Not separated
642	1	Separated
643	1	Separated, overseas
644	1	Not married
645	1	Not recorded

2. General Military Variables

a. Air Force Base and Command of Referral

		If base of referral is
5	1	AE (Altus)
6	1	AF (Amarillo)
7	1	AH (Andrews)
8	1	BB (Barksdale)
9	1	BF (Biggs)
10	1	BH (Bolling)
11	1	CA (Carswell)
12	1	CB (Castle)
13	1	CD (Chanute)
14	1	EB (Eglin)
15	1	ED (Ellsworth)
16	1	EE (Elmendorf)
17	1	FH (Ft. Leavenworth)
18	1	FK (Francis E. Warren)
19	1	GC (George)
20	1	HA (Hamilton)
21	1	HJ (Hunter)
22	1	KA (Keesler)
23	1	KF (Kirtland)
24	1	LA (Lackland))
25	1	LI (Lincoln)

Appendix II (*Continued*)

Variable Number	Integer Value	Variable by Classification Category
		If base of referral is (*Continued*)
26	1	LL (Lompoc)
27	1	LO (Lowry)
28	1	MF (McGuire)
29	1	MK (March)
30	1	MO (Maxwell)
31	1	MQ (Mitchell)
32	1	OA (Offutt)
33	1	PC (Parks)
34	1	RB (Randolph)
35	1	SB (Sampson)
36	1	SE (Scott)
37	1	SG (Selfridge)
38	1	SI (Shaw)
39	1	SJ (Sheppard)
40	1	TC (Travis)
41	1	WA (Walker)
42	1	WD (Westover)
43	1	WJ (Wright-Patterson)
44	1	Other
		If Command of referral is
45	1	Air Defense Command
46	1	Air Training Command
47	1	Air Research Development Command
48	1	Air Force Logistics Command
49	1	Air Materiel Command (same as AFLC)
50	1	Alaskan Air Command
51	1	Air Proving Ground Center
52	1	Air University
53	1	Air Force Systems Command
54	1	Continental Air Command
55	1	Headquarters Command United States Air Force
56	1	Military Airlift Command
57	1	Pacific Air Force
58	1	Strategic Air Command
59	1	Tactical Air Command
60	1	United States Disciplinary Barracks
61	1	United States Air Force in Europe
62	1	United States Air Force Security Service
63	1	Other

Variable Number	Integer Value	Variable by Classification Category
		2. General Military Variables
		b. Specialty Aptitude Score, Specialty Assigned, Skill Level
64	Continuous	Airman Qualifying Examination Mechanical Score
65	Continuous	Airman Qualifying Examination Administrative Score
66	Continuous	Airman Qualifying Examination General Score
67	Continuous	Airman Qualifying Examination Electronics Score
		If first two digits of Air Force Specialty Code at arrival are
72	1	00 (No specialty)
73	1	27 (Aerospace Ops Control Operator)
74	1	29 (Communications Ops)
75	1	30 (Comm-Elec Operator)
76	1	32 (Arm Sys Operator)
77	1	42 (Aircraft Accessories Maint)
78	1	43 (Aircraft Maint)
79	1	46 (Munitions & Weapons Maint)
80	1	47 (Motor Vehicle Maint)
81	1	53 (Metal Working)
82	1	55 (Structural & Pavements Helper)
83	1	56 (Sanitation Helper)
84	1	60 (Transportation)
85	1	62 (Food Service)
86	1	64 (Supply)
87	1	70 (Admin)
88	1	73 (Personnel)
89	1	77 (Security Police)
90	1	90 (Medical)
91	1	96 (Prisoner)
92	1	Other
		If next-to-last digit of skill level Air Force Specialty Code at arrival is
93	1	1 (Helper)
94	1	3 (Apprentice)
95	1	5 (Specialist)
96	1	7 (Supervisor)
97	1	9 (Superintendent)
		If Air Force Qualification Test Category is
201	1	Not recorded
202	1	I
203	1	II
204	1	III
205	1	IV
206	1	V

Variable Number	Integer Value	Variable by Classification Category
		If number of career fields entered is
667	1	1
668	1	2
669	1	3
670	1	None
671	1	Not recorded
		If first Air Force Specialty acquired through
672	1	Technical school
673	1	On-the-job training
674	1	No Air Force Specialty Code
675	1	Not recorded
		If number of technical school phase-outs is
676	1	0
677	1	1
678	1	2
679	1	No technical school attendance
680	1	Not recorded
		If number of technical schools attended is
681	1	1
682	1	2 or more
683	1	0
684	1	Not recorded

2. General Military Variables
c. Enlistment and Rank Data

118	Continuous	Years of prior military service
119	Continuous	Months remaining on current enlistment
120	Continuous	Months served on present enlistment
		If highest grade held is
121	1	Senior or Chief Master Sergeant
122	1	Master Sergeant
123	1	Technical Sergeant
124	1	Staff Sergeant
125	1	Airman First Class
126	1	Airman Second Class
127	1	Airman Third Class
128	1	Airman Basic
129	1	Officer
130	1	Not recorded

Appendix II (*Continued*)

Variable Number	Integer Value	Variable by Classification Category
		If age at first enlistment is
654	1	22 years
655	1	21 years
656	1	20 years
657	1	19 years
658	1	18 years
659	1	17 years
600	1	Not recorded
		3. Offense Variables
		a. Previous Civilian and Military Offenses, Sentences, etc.
131	Continuous	Number of prior military convictions
		If type of prior military offenses is Uniform Code of Military Justice Article number
132	1	085, 086 (AWOL)
133	1	087, 088, 089, 090, 091, 092, 093, 094, 099, 100, 102, 103, 104, 105, 106, 110, 112, 113, 114, 133, 134 (Military offenses)
134	1	107, 108, 121, 123, 126, 127, 131, 132 (Dishonesty)
135	1	118, 119, 122, 124, 128, 129, 130 (Violence)
136	1	120, 125 (Sex)
137	1	Other
157	Continuous	Number of Article 15s (Uniform Code of Military Justice) received previous to offense
231	Continuous	Total number of days prior military confinement (prior to present offense)
		3. Offense Variables
		b. Present Offense
		If present primary offense Uniform Code of Military Justice Article number is
138	1	085, 086 (AWOL)
139	1	087, 088, 089, 090, 091, 092, 093, 094, 099, 100, 102, 103, 104, 105, 106, 110, 112, 113, 114, 133, 134 (Military offenses)
140	1	107, 108, 121, 123, 126, 127, 131, 132 (Dishonesty)
141	1	118, 119, 122, 124, 128, 129, 130 (Violence)
142	1	120, 125 (Sex)
143	1	Other

Variable Number	Integer Value	Variable by Classification Category
		If present secondary offense Uniform Code of Military Justice Article number is
144	1	085, 086 (AWOL)
145	1	087, 088, 089, 090, 091, 092, 093, 094, 099, 100, 102, 103, 104, 105, 106, 110, 112, 113, 114, 133, 134 (Military offenses)
146	1	107, 108, 121, 123, 126, 127, 131, 132 (Dishonesty)
147	1	118, 119, 122, 124, 128, 129, 130 (Violence)
148	1	120, 125 (Sex)
149	1	Other
		If number of accomplices is
272	1	3 or more
273	1	2
274	1	1
275	1	0
276	1	Not recorded
		If retrainee's age at time of offense is
277	1	24 years or older
278	1	23 years
279	1	22 years
280	1	21 years
281	1	20 years
282	1	19 years
283	1	18 years
284	1	17 years
285	1	Not recorded
		If retrainee's indebtedness at time of offense is
286	1	$3,000 or more
287	1	$2,000 to $2,999
288	1	$1,000 to $1,999
289	1	$500 to $999
290	1	$300 to $499
291	1	$100 to $299
292	1	Under $100
293	1	Not recorded
		If alcohol involved in offense is
294	1	No alcohol involved
295	1	Some alcohol involved
296	1	Drunk at time of offense
297	1	Not recorded

Variable Number	Integer Value	Variable by Classification Category
		3. Offense Variables
		c. Court-Martial for Present Offense
226	Continuous	Number of days in pre-trial confinement
227	Continuous	Number of days in post-trial confinement
		If plea is
265	1	Not guilty
266	1	Guilty
267	1	Not recorded
		If attitude toward Court-Martial is
268	1	Fair
269	1	Neutral
270	1	Unfair
271	1	Not recorded
		3. Offense Variables
		d. Sentence from Present Court-Martial
		If pay forfeiture is
150	1	None
151	1	Partial
152	1	Total
153	1	Not recorded
154	Continuous	Months confined to hard labor
228	Continuous	Number of days remaining at arrival until minimum release date
		If punishment is
260	1	No discharge
261	1	Bad conduct discharge
262	1	Dishonorable discharge
263	1	Other
264	1	Not recorded
		4. Measures while in Retraining Group
161	Continuous	Otis Intelligence Test Score
229	Continuous	Number of days in retraining program
230	Continuous	Number of days in casual status (awaiting reassignment or discharge)

Variable Number	Integer Value	Variable by Classification Category
		Minnesota Multiphasic Personality Inventory Scores at arrival
232	Continuous	L Scale
233	Continuous	F Scale
234	Continuous	K Scale
235	Continuous	HS Scale
236	Continuous	D Scale
237	Continuous	HY Scale
238	Continuous	PD Scale
239	Continuous	MF Scale
240	Continuous	PA Scale
241	Continuous	PT Scale
242	Continuous	SC Scale
243	Continuous	MA Scale
244	Continuous	SI Scale
259	1	If retrainee sent to base guardhouse while in retraining program
		If stated intention is to make a career of the Air Force (at time of entry into the Retraining Group) is
661	1	Yes
662	1	Probably
663	1	Undecided
664	1	Probably not
665	1	No
666	1	Not recorded
		If permission granted while in Retraining Group for Red Cross interview of family is
685	1	Yes
686	1	No
687	1	Not recorded

5. Criteria

1	1	If Criterion 1 (Discharged)
2	1	If Criterion 2 (Returned to duty–success)
3	1	If Criterion 3 (Returned to duty–failure)

Validity and Weight of Variables Included in the 61-Variable Multiple Regression System [a]

Variable Number[b]	Validity	Regression Weight
23	−0.01710320	−0.18055763
25	0.05322394	0.31923011
36	0.05182232	0.14169920
41	0.05504114	0.20708951
47	0.04539617	0.12667454
53	0.00128224	0.24195480
71	0.17721854	0.15126214
76	0.06984686	0.13695114
84	−0.04195735	−0.08124315
86	−0.03698206	−0.05905929
119	−0.20640351	−0.00434017
122	0.06432974	0.26173016
131	−0.10754389	−0.03631606
138	−0.17884628	−0.08350772
141	0.14247970	0.11839490
157	−0.05829812	−0.02213789
164	0.09003716	0.06242317
209	0.13035022	0.08048369
211	−0.03580984	−0.21879340
224	−0.07731398	−0.10484569
230	0.09980794	0.00109953
233	−0.13287515	−0.00461087
246	−0.02365684	−0.20318474
259	−0.15575136	−0.13383982
262	0.14172668	0.10214040
286	0.06155357	0.21299567
299	−0.01435141	−0.11056525
324	0.01646149	0.15435730
353	−0.07928066	−0.07713204
374	−0.02712143	−0.05657826
389	0.04826286	0.06937339
413	−0.00334366	−0.11877770
417	−0.03431201	−0.15802218
425	−0.04285057	−0.20202191
428	0.06145944	0.15652340
431	−0.04840960	−0.03786192
434	−0.03359916	−0.11867259
440	0.05731330	0.15327608
453	−0.04063591	−0.22928669
470	−0.06083556	−0.21020532
484	0.11164999	0.10147967
493	−0.08888108	−0.03666138

Appendix III (*Continued*)

Variable Number[b]	Validity	Regression Weight
497	0.04716018	0.07386584
520	−0.04846448	-0.09698509
526	0.08584940	0.08982285
540	−0.01795728	−0.03684022
548	−0.04097044	−0.17976334
553	0.03203573	0.05252052
555	0.06396643	0.06614165
564	0.00221434	−0.03974780
569	−0.03314068	−0.25007741
570	−0.01547396	−0.04374462
577	−0.07459743	−0.10601846
584	0.03270849	0.05089767
627	0.04023091	0.11299190
637	−0.01793704	−0.07010495
648	0.05868946	0.03938557
664	−0.01948364	−0.07268168
665	−0.14459836	−0.10465017
676	0.13981233	0.08529307
687	0.13569040	0.15062711
	Regression Constant	0.49211314

[a] A 61-variable regression equation can be constructed from these data using the formula $P_i = \sum_{i=1}^{n} w_i v_i$, where P_i is a predicted score, w_i a regression weight, and v_i the value of a variable.

[b] Substantive meaning of predictor variables is given in Appendix II.

Appendix III (*Continued*)

Validity, Weight, and Description of Variables Included in the 13-Variable Multiple Regression System[a]

Variable Number	Validity	Regression Weight	Variable Description
36	0.05182232	0.14646825	Base of referral: Scott AFB
71	0.17721854	0.13193651	G.E.D. not necessary; H.S. diploma received
119	−0.20640351	−0.00489408	Months remaining on current enlistment
131	−0.10754389	−0.04879933	Number of prior military convictions
138	−0.17884628	−0.06473952	Present offense = 085, 086 (AWOL or desertion)
141	0.14247970	0.12196373	Present offense = 118, 119, 122, 124, 128, 129, 130 (Violence)
164	0.09003716	0.06281574	No criminality among members of family
259	−0.15575136	−0.16086727	Sent to base guardhouse
262	0.14172668	0.08147961	Dishonorable discharge in court-martial sentence
353	−0.07928066	−0.07587349	Mother did not work
440	0.05731330	0.15990695	Father served in no Military
665	−0.14459836	−0.09143988	No intent to make career of Air Force
676	0.13981233	0.09358041	Never removed from Technical school
	Regression Constant	0.54281772	

[a] A 13-variable regression equation can be constructed from these data using the formula $P_i = \sum_{i=1}^{n} w_i v_i$, where P_i is a predicted score, w_i a regression weight, and v_i the value of a variable.

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APPENDIX IV

FORMAT FOR TABLE TO BE USED IN APPLICATION OF PREDICTED SCORES

The proposed application of the prediction instrument presented in Appendix I requires the use of tables based on the most recent cross-validation results indicating the success or failure of approximately 400 to 800 retrainees sent back to active duty. This section shows a sample of such a table.

The second column of such a table would show the number of retrainee cases from the most recent cross-validation who have a score at or near the predicted score interval listed in the first column. A minimum of 50 cases would be listed for each interval, and these would be drawn from the particular interval in question and from as many adjacent intervals as would be necessary to accumulate the minimum of 50 cases.

The third and fourth columns would indicate the number and percentage, respectively, of the 50 or more cases who were successful when returned to active duty. Columns five and six would contain the corresponding figures for failure.

The user of such tables could quickly interpret the meaning of the predicted score for a retrainee on whom a decision is to be made. For example, if a commander has before him a case recommended by the Final Classification Board for return to duty, but the predicted score on this individual is 0.32, the Commander can see that of X number of men (Column 2) with a score at or near 0.32, Y per cent (Column 6) were failures.

Appendix IV (*Continued*)

Sample Format

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
Predicted Score	No. Cases at or Near this Score	No. of Success	Percentage of Success	No. of Failures	Percentage of Failures
1.00					
.99					
.88					
.					
.					
.					
.65			(Values in this table to be derived from cross-validation when complete.)		
.45					
.44					
.43					
.					
.					
.					
0.00					

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3. ABSTRACT

This report documents the progress in developing and validating a prediction device for use in aiding decisions to return to active duty or discharge Air Force prisoners sent to the Retraining Group. First, there is an extensive review of the methodology and results of efforts to predict delinquency, recidivism, and military unsuitability. Then, two multiple regression analyses made on a sample of 1,303 former retrainees are reported. Each of the analyses yielded encouraging results in an initial cross-validation on 138 more recent retrainee cases for which actual criterion data were available. The cross-validation procedure was limited to making predictions on only 71 cases where the value of the multiple regression predicted score was sufficiently high or low to assure satisfactory accuracy. The best of the two regression equations, a 13-predictor system, was 77.4 per cent accurate in predicting successful return to duty and 72.5 per cent accurate in predicting unsuccessful return to duty. Details for applications of such a system, once adequately validated, to the operational decision-making process of the Retraining Group are given.

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