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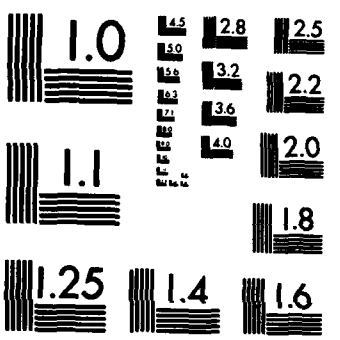

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TECHNICAL MEMORANDUM 83-6

PREDICTING ACADEMIC ATTRITION FROM CRYPTOLOGIC TECHNICIAN (CT) "A" SCHOOLS USING ASVAB AND MORSE CODE PERFORMANCE

JULY 1983

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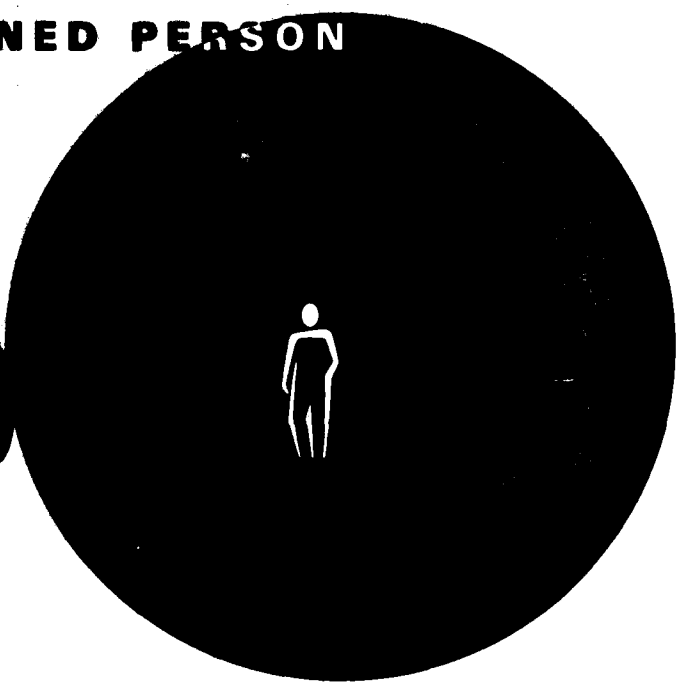

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Technical Memorandum 83-6

PREDICTING ACADEMIC ATTRITION FROM CRYPTOLOGIC TECHNICIAN (CT) "A" SCHOOLS USING ASVAB AND MORSE CODE PERFORMANCE

William C. Rankin

Training Analysis and Evaluation Group

July 1983

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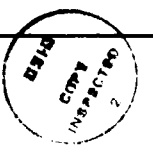

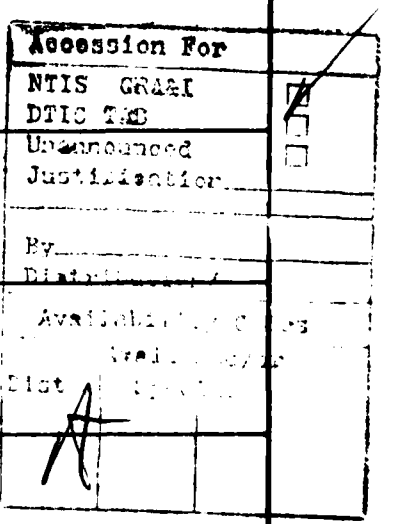

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This study examined the predictability of academic attrition from the Cryptologic Technician (CT) courses in which Morse code receiving is trained. This was to provide information on whether a new test procedure should be developed. School data were analyzed and, because of limitations on data interpretation, there was no particular support for developing new paper-and-pencil testing. That is, a new type of Morse aptitude testing procedure will be required.

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SECTION I

INTRODUCTION

Two of the Navy's six Cryptologic Technician (CT) occupation groups have a requirement to be trained to receive Morse code aurally. These are the Cryptologic Technician, Technical (CTT) and Cryptologic Technician, Collection (CTR). The CTTs and CTRs learn how to receive Morse code at the Navy Technical Training Center (NTTC), Corry Station, Pensacola, Florida, in two Navy "A" school courses.

Academic attrition of trainees who fail to receive code at the "A" schools' minimum required rates has always been of concern to these schools because of the associated loss of resources and the resultant higher cost to produce a graduate. Nonacademic attrition (for behavioral, medical, or security reasons) is obviously also a concern; however, nonacademic attrition is less likely to be ameliorated than academic attrition through improvement in trainee aptitude selection and training policy. The TAEG was tasked to study the academic attrition problem and look for possible solutions.[1]

The present study focused on the problem of predicting academic attrition from Morse code training; i.e., failure to learn to receive code at the minimum required words per minute. Specifically, the CT school was interested in the development of a new Morse code aptitude test/selection procedure that would improve prediction of academic success/failure. Because of the expense involved in new test development and the long history of difficulty in predicting Morse code achievement, it was decided to examine the predictability of Morse code performance using actual training performance data. Thus, before costly exploratory test/procedural developments are undertaken, some estimate of the predictive upper limits should be found.

THE CT SCHOOL HYPOTHESIS

Instructors at the CTR and CTT schools occasionally maintain that fairly early in training they can identify trainees who will be unsuccessful at attaining the minimum Morse receiving rates. This may be true for some extreme instances. However, the hypothesis has practical significance if early Morse training were predictive of later or ultimate Morse training success. That is, the practical utility of predicting whether a trainee will be successful early in training would enable the CT school to identify and reclassify trainees for transfer to the other CT branches which do not require Morse receiving skill on the job. Unsuccessful CTRs and CTTs would not necessarily be lost to the CT community, but rather could be trained to perform as Cryptologic Technician Administrative (CTA) or Cryptologic Technician Operator (CTO).

[1]CNET ltr Code N-5 of 15 May 1980.

BACKGROUND

Academic attrition from the two CT courses in FY 1976 and FY 1977 has been 10 percent and 14 percent for the CTTs and 17 percent and 16 percent for the CTRs (Hodak, Middleton, Rankin, and Papetti, 1979). In the first 6 months of FY 1983, the rates for CTRs and CTTs were 11 percent and 16 percent, respectively.

These levels of attrition persist even after a screening process that includes aptitude tests from the Armed Services Vocational Aptitude Battery (ASVAB) and a specifically designed Morse code receiving aptitude test, the Radio Code Aptitude Test (RCAT). In studying various ASVAB test combinations for their predictive validity, Swanson (1979) found very low (.00 - .10) correlations between the various ASVAB combinations and a criterion of graduate-attrite. This was even more disappointing since Swanson took into account, statistically, the fact that the CTRs and CTTs in his studies were preselected groups; i.e., the trainees in the Swanson studies were already above the schools' selection minima for ASVAB and RCAT scores.

Thus, the state-of-the-art in predicting Morse code receiving skill is not much better than chance. Servinsky (1980) reviewed the Morse aptitude measurement problem from its long, historical perspective. In essence, years of research show that the ability to learn Morse code is apparently a special aptitude unrelated to other aptitudes or skills. The conclusion to be drawn from the Servinsky report is that development of a new Morse aptitude "test," while highly desirable, is likely to fail, if it is a test very much like those tried previously.

SECTION II

APPROACH

This section describes the approach taken to assess the current predictability of attrition from Morse training at the CTR and CTT "A" schools. The approach was correlational; i.e., ASVAB test scores and times to complete early stages of Morse training were correlated with a dichotomous "graduate vs academic attrite" criterion. The rationale behind this approach was to explore the predictive potential of the variables for which data were more readily available. Descriptions of the data sources, variables, and analyses performed follow.

DATA SOURCES

Two sets of data were developed--one for the CTRs and one for the CTTs. Both sets were from the same sources. Part of the data was provided by the Chief of Naval Education and Training (CNET), Code N-7, in the form of extracts from the Student Master File (SMF) of the Navy Integrated Training Resources and Administration System (NITRAS). The data elements of interest from SMF were individual trainee scores on the various tests in the ASVAB and also, where available, the Radio Code Aptitude Test (RCAT) and the Foreign Language Aptitude Test (FLAT). The remaining data were provided by the CT school. These data were trainee times-to-complete units of Morse training and whether the trainee was graduated or dropped from the course as an academic or nonacademic attrite.

The data from the two sources; i.e., SMF and school records, were merged on the basis of student identification number (SSN). Both CTR and CTT data sets were limited to the number of graduates/attrites for which school data were available. These data were from graduates/attrites during FY 1980.

THE VARIABLES

Table 1 contains a listing of the potential predictors of graduation or academic attrition from Morse code training. The majority of these variables are from the ASVAB. These variables are the least expensive for the Navy to obtain as predictors of academic success in a variety of "A" schools and they are routinely used for that purpose. Unfortunately, the ASVAB variables have not had much practical utility in predicting success in Morse code training for CTRs and CTTs. The variables reflecting actual performance in Morse training; i.e., times-to-complete (and/or grades for the CTT data set) actual units of instruction, have, potentially, much more "face validity" and predictive utility. However, the Morse performance variables are obviously more costly to obtain since they are available only after selection and classification.

THE ANALYSIS

Correlations with the dependent variable, graduate or academic attrite, were obtained for both the ASVAB and the first four units of actual Morse

training times. Also, stepwise regression analyses were run for both data sets. A breakdown analysis of means on all predictor variables was examined to compare profiles of graduates with academic attrites and nonacademic attrites. Conditional probabilities for predictive success were estimated from a typical regression solution. Results of the operations on the data are presented in section III.

TABLE 1. POTENTIAL PREDICTORS OF GRADUATION OR ACADEMIC ATTRITION FROM MORSE CODE TRAINING

ASVAB Variables
Word Knowledge (WK)
Arithmetic Reasoning (AR)
Mechanical Comprehension (MC)
Numerical Operations (NO)
Attention to Detail (AD)
Shop Information (SI)
Mathematics Knowledge (MK)
Electronics Information (EI)
General Science (GS)
Radio Code Aptitude Test (RCAT)
Foreign Language Aptitude Test (FLAT)
Times or Grades in Morse Units of Instruction

SECTION III

RESULTS

This section summarizes the results for the CTR and CTT data sets. The order of presentation shows a breakdown of means (averages) on all the variables considered, then the best prediction found by multiple regression, together with an evaluation of the predictive utility.

CTR RESULTS

Table 2 contains the means of all the variables considered, broken down by graduates, academic attrites, and nonacademic attrites. Inspection of table 2 reveals a consistent pattern for the nonacademic attrites; their averages are more nearly like the graduates than are the academic attrites, although the differences are not of a practical magnitude. The same kind of relationship between mean profiles of graduates, academic, and nonacademic attrites holds for the CTTs. The implication is that the attrites appear to be well categorized by the staff at the CT schools. Thus, the criterion to be predicted, in these data sets; i.e., "graduate vs academic attrite," seems fairly accurate.

TABLE 2. BREAKDOWN OF MEANS FOR CTR GRADUATES AND ATTRITES

VARIABLE	ASVAB STANDARD SCORES		
	GRADUATES	ACADEMIC ATTRITES	NONACADEMIC ATTRITES
Word Knowledge	55.4	54.2	54.4
Arithmetic Reasoning	54.2	51.6	53.4
Mechanical Comprehension	49.9	47.8	48.4
Numerical Operations	54.2	49.8	53.3
Attention to Detail	53.4	50.6	54.1
Shop Information	48.3	48.1	48.7
Mathematics Knowledge	54.8	51.8	52.9
Electronics Information	51.2	49.8	50.7
General Science	52.6	50.0	53.1
Foreign Language Aptitude	69.8	68.4	68.4
TIMES IN MORSE UNITS		(IN DAYS)	
Unit 1	2.7	4.8	4.0
Unit 2	2.7	4.2	3.3
Unit 3	3.7	6.3	4.2
Unit 4	5.3	11.4	7.1
Unit 5	3.6	6.9	4.4
Unit 6	4.7	12.1	5.6
Unit 7	6.5	13.5	8.5
Unit 8	4.8	8.6	4.6
Unit 9	10.3	13.3	10.1
Unit 10	5.4	3.0	4.5

BEST PREDICTION FOUND. For the CTR data set, the multiple correlation between predictors and the criterion was R = .28. The set of predictors were, in order of contribution to prediction, Unit 2, SI, NO, WK, MC, Unit 3, Unit 1, GS, FLAT, AR, Unit 4, and EI. The set of predictors included trainee performance on the first three units of Morse training. This resulted in a slight improvement in prediction based on ASVAB variables alone. Prediction based simply on the first four units of Morse training revealed a multiple correlation of R = .15.

EVALUATION OF PREDICTION. Further analysis, shown in table 3, compared the "predicted vs actual" status based on the first four units of Morse instruction.

TABLE 3. COMPARISON OF PREDICTED VS ACTUAL STATUS OF GRADUATES AND ACADEMIC ATTRITES

		PREDICTED		
		Graduate	Academic Attrite	Total
ACTUAL	Graduate	104	108	212
	Academic Attrite	26	51	77
	Total	130	159	289

The probability of correct prediction was only 155/289 or .54, which was only slightly better than a coin toss. If one were to predict "all will graduate," the resulting baseline success rate turned out to be 212/289 or .73. Thus, the predictability of academic performance was not very good; i.e., there is very little support for the hypothesis that instructors can identify attrites early in training. It should be remembered this was a preselected group. One must also consider that the predictability implied by the multiple prediction based on both ASVAB and Morse performance (R = .28) is maximized on this data set. A shrunken multiple R estimate for what would be expected on other data sets is about .17; simply not a practically useful correlation.

CTT RESULTS

Table 4 contains the means of all the variables considered, broken down by graduates, academic attrites, and nonacademic attrites. The pattern is

TABLE 4. BREAKDOWN OF MEANS FOR CTT GRADUATES AND ATTRITES

VARIABLE	ASVAB STANDARD SCORES		
	GRADUATES	ACADEMIC ATTRITES	NONACADEMIC ATTRITES
Word Knowledge	57.0	54.0	55.9
Arithmetic Reasoning	54.6	53.3	53.8
Mechanical Comprehension	50.4	47.3	48.6
Numerical Operations	54.8	51.4	53.6
Attention to Detail	52.6	50.4	48.7
Shop Information	48.1	49.2	48.8
Mathematics Knowledge	55.0	53.0	53.2
Electronics Information	51.9	49.4	50.3
General Science	54.2	51.0	52.4
Foreign Language Aptitude	69.3	67.1	69.7
TIMES IN MORSE UNITS		(IN DAYS)	
Unit 1	3.2	6.8	4.3
Unit 2	4.8	10.3	6.5
Unit 3	4.4	6.5	5.3
Unit 4	5.8	8.9	8.9
Unit 5	3.4	4.2	3.6
Unit 6	9.0	11.0	10.8
Unit 7	3.4	3.9	3.9
Unit 8	6.3	9.0	7.3
Unit 9	2.5	1.5	2.4
GRADES IN MORSE UNITS		(UNIT GRADES IN %)	
Unit 1	76	missing	missing
Unit 2	87	81	85
Unit 3	89	83	85
Unit 4	88	81	84
Unit 5	87	83	84
Unit 6	89	82	85
Unit 7	89	81	86
Unit 8	88	81	84
Unit 9	87	83	84

quite similar to that of the CTRs. Because of the low predictability of attrition based on ASVAB variables observed with both the CTR data set and the Swanson studies cited earlier, no analysis was made using ASVAB variables with the CTT data set. Rather, attention was focused on the two forms of actual course performance variables; i.e., time to complete units and grades received in units of instruction. These two variables appear to do a much better job of predicting "graduate vs academic attrite" than was observed for the CTR data set. The multiple correlation between days to complete a unit, for the first four units, with the criterion of "graduate vs academic attrite" was R = .51. The multiple correlation with the criterion using grades received in each of the first four units of instruction was R = .65.

EVALUATION OF PREDICTION. Correcting the two preceding validity coefficients for "days" and "grades" yields shrunken multiple R's of .50 and .65, respectively. The reason for the relatively minor shrinkage adjustment stems from the fact that the number of predictors in either case was small (first 4 "days" and first four "grades") relative to the number of observations (224). Thus, it would appear that CTT "graduate vs academic attrite" is significantly more predictable than with the CTR course. This indicates that the school hypothesis is better founded for the CTTs. In other words, it is possible that a cutoff could be established to identify, earlier, those CTTs who are more likely to be academic attrites. And, conceivably the potential academic attrite from the CTT school could be usefully transferred to other CT branches although probably not the CTR branch. However, the practical utility of this is not very good because the coefficients of determination are still quite low (.25 and .42).

LIMITS ON DATA INTERPRETATION

The results for the CTR data are, unfortunately, more nearly like those elsewhere in the literature. That is, predictability of Morse code proficiency at the levels required by the CTR rating is very low. The CTT results are confounded and cannot be interpreted clearly because the CTT course differs from the CTR course in two important ways. The first difference is a lower code receiving requirement than for the CTRs. This would make code performance slightly more predictable because of the more lenient criterion (see for example Fleishman and Fruchter, 1960). The second difference is in the content of what else is learned in the CTT course in addition to Morse. The CTTs also must learn the operation of various non-Morse encryption receiving equipments.

Another limitation on the interpretation of results stems from the fact that the data did not come from a controlled experiment. Available school records data were utilized. Consequently, the dependent variable was simply the dichotomous "graduate vs academic attrite." In a controlled experiment, the dependent variable might have been "time to achieve a rate" or "final school grade." These presumably are more predictable criteria.

Finally, both courses changed to a group-paced teaching format beginning approximately with FY 1982. However, course requirements have remained about the same; i.e., CTRs still have the principal burden of learning to receive (copy) Morse code at better than 20 wpm. CTTs still have the lower receiving requirement but must learn the operation of non-Morse information gathering equipment.

SECTION IV

RECOMMENDATIONS

The suggested recommendations are based on the empirical results of the study and also on logical inferences from the data and from discussions with school staff and Training Program Coordinators (TPCs). The recommendations are listed in order of increasing cost and developmental risk.

- Use the present selection criteria until a better prediction scheme can be demonstrated. At present both CTT and CTR minima are WK + AR = 98 and RCAT = 60.

- Revise the RCAT to a length more amenable to reliable measurement. The RCAT resembles most closely the training task for Morse code learning.

- Conduct a pilot program for transferring slower CTR students to the CTT branch which has a lower wpm requirement. Transfer would be on the basis of recommendation by the school's academic review board. It is not clear whether transferring the more rapid Morse receivers from the CTT branch to the CTR course would be feasible.

- Determine the administrative feasibility of inputting slightly fewer trainees into the CTO or CTA branches so that attrites from the CTR and CTT branches (with adequate typing ability) can transfer if they cannot achieve Morse training requirements. Again, transfer decisions would require the recommendation of an academic review board. This would salvage some of the attrites for the CT community.

- Initiate Research and Development efforts to develop new prediction techniques. Two areas show some potential for success: psychobiological predictors and compressed speech recognition. Psychobiological prediction R&D has been attempted for sonar operator performance (Lewis & Rimland, 1980) and compressed speech recognition in relation to Morse code receiving (Servinsky, 1980).

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