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Revision of the United States Naval Academy Selection Composite

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This research investigated alternative methods of weighting predictors in the Candidate Multiple, the U.S. Naval Academy's selection composite, to determine whether validities could be improved against criteria of academic and military performance and attrition at the Academy. Using student and applicant data for the classes of 1983, 1984, and 1987, adjustments were made to correct for the effects of selection on predictor-criterion correlations. Corrected validities were then used to construct alternative composites that differed from each other in terms of which predictor weights were predetermined by the Academy and which were free to be empirically optimized. Composites were cross-validated on the class of 1988 and compared with earlier operational versions of the Candidate Multiple. Results indicated that all four experimental composites improve the prediction of Academy criteria as compared to previous operational composites. It was recommended that predictor weights in the Candidate Multiple be modified to reflect this result. In accordance with this recommendation, the Academy adopted a modification of one of the experimental composites for use with the class of 1990.

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FOREWORD

This report describes the development and evaluation of an improved selector composite that predicts an applicant's likely academic and military performance at the Naval Academy more accurately than previous composites. Although Naval Academy students are already of superior caliber, the use of this composite is expected to result in further improvement in quality.

This effort was conducted in response to a request by U.S. Naval Academy to provide continuous monitoring and validation of the midshipmen selection procedures.

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SUMMARY

Problem

An empirically-developed composite called the Candidate Multiple has been used by the Naval Academy since 1975 to aid in selecting midshipmen. Since the composite was implemented, several events have made it desirable to investigate re-weighting the predictors to improve prediction. First, data is now available to correct for the effects of the selection process itself when determining the optimal weights; and second, average SAT scores have replaced single highest SAT scores in the composite, altering the relationships of predictor variables to each other and most likely altering the optimal predictor weights.

Objective

The purpose of this research is to investigate the empirical re-weighting of predictors in the Candidate Multiple with the intent of improving the Multiple's ability to predict academic, military, and attrition criteria at the Naval Academy.

Approach

The Candidate Multiple includes seven predictor variables that are used to predict academic and military performance as well as attrition at the Academy. These predictor variables include verbal and mathematics subtests of the SAT, rank in high school class, high school teachers' recommendations, extracurricular activities, and two scores derived from a vocational interest inventory. To investigate alternative methods of weighting these variables to predict the criteria, applicants to the Classes of 1983, 1984, and 1987 (N = 8,264) were used to correct predictor-criterion correlations for the effects of selection. These corrected correlations were then applied to selectees in the same classes (N = 2,835) to derive four experimental selector composites. The composites differed in terms of which predictor weights were pre-determined by the Academy for policy reasons and which were empirically optimized. The four experimental composites were then cross-validated on the Academy Class of 1988 and compared with earlier operational versions of the Candidate Multiple.

Results and Conclusions

All four of the experimental composites were more valid than the previous operational composites for predicting academic performance and academic disenrollment. As expected, improvement in predicting these criteria was greatest when all variables were free to assume empirically-determined weights and decreased as more constraints were placed on the empirical weighting process.

Recommendations

Modify predictor weights used in the Candidate Multiple to reflect the weights empirically derived in this research. (The Academy did, in fact, adopt a modification of one of the experimental composites for use with the Class of 1990.) Continue research to expand the range of criteria that can be predicted by the Candidate Multiple.

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INTRODUCTION

Problem

For a number of years, selection of midshipmen for the Naval Academy has been based largely on a composite score known as the Candidate Multiple. Initially, the weights attached to each of the variables in the composite were rationally determined by expert judges and rationally revised and updated from time to time.

In 1975, as requested by the Superintendent, U.S. Naval Academy, the empirical weighting of predictors was instituted toward the goal of improving the efficiency of the selection composite for predicting academic, military, and disenrollment criteria at the Academy as well as choice of major.

Since 1975, several factors have made it desirable to revise the Candidate Multiple. First, data is now available to improve estimation of the influence of pre-selection (restriction of range) on the effectiveness of the components of the Candidate Multiple. Second, research conducted for the Naval Academy by the Navy Personnel Research and Development Center (NAVPERSRANDCEN) has indicated that prediction of academic criteria can be improved in cases where there are multiple administrations of the Scholastic Aptitude Test (SAT) or American College Test (ACT) using the average of each candidate's scores, rather than the highest such score (Cowen & Abrahams, 1982). Other things being equal, use of the average score (implemented with the class of 1987) should influence the weights that SAT and other variables receive in the Candidate Multiple.

Objectives

The purpose of this research was to investigate a revision of the weights assigned to predictors in the Candidate Multiple to further improve the efficiency of the selection composite. Specific objectives were (1) to optimally weight the individual predictors against academic, military and attrition criteria at the Academy, and (2) to counteract the influence of pre-selection when deriving the optimal weights.

PROCEDURES

Subjects

Subjects included both applicants and selectees from the Naval Academy classes of 1983, 1984, and 1987, and selectees only from the class of 1988. The applicants, totalling 8,264 individuals, were included to permit corrections for the effects of selection on validity coefficients. The selectees were required for development (classes of 1983, 1984, and 1987) and cross-validation (class of 1988) of the revised predictor weights in the Candidate Multiple. Selectees were distributed among the four class groups as follows: 1983 (N = 1,061), 1984 (N = 945), 1987 (N = 829), and 1988 (N = 1,192).

The four year groups were chosen because they were among the most recent to have (1) complete records of all SAT and ACT that were needed to compute average SAT score values, and (2) the most recent versions of interest test scores. (The class of 1985 was omitted because it was missing complete SAT information and the class of 1986 because it was missing the interest test scores used in the present multiple.) Several year groups were included to ensure that results obtained would be stable over time.

Predictors

The following predictor scores were available for all four classes and for the applicant samples:

1. Scholastic Aptitude Test--Verbal (SATV) or its empirically-derived ACT equivalent. This score represents the verbal aptitude of the individual as measured in a national competitive testing program designed for college admissions and scholarship awards. For the classes in this sample, a minimum score of 520 was required for Naval Academy qualification. In exceptional cases, waivers have been allowed for those scoring below 520. For each individual who took the SAT and/or ACT more than once, an average SATV score was computed.

2. Scholastic Aptitude Test--Mathematics (SATM) or its empirically-derived ACT equivalent. This score is parallel to SATV except that it represents an individual's quantitative aptitude. Since the curriculum at the Naval Academy is heavily weighted with engineering and science courses, the minimum qualifying SATM score for the four classes in this study was 600. Waivers were allowed in exceptional instances for those scoring below this value. As with SATV, an average SATM score was computed for each individual who took the SAT and/or ACT more than once.

3. Rank in Class (R/C). This is a standardized score ($x = 500$, S.D. = 100), which is based on an individual's high school rank and ranges between 200 and 800.

4. Recommendations (REC). This is a score based on high school officials' estimates of the individual's potential for success as a naval officer. These officials (normally English or Mathematics teachers) are asked to evaluate the candidate on effective communication skills, interpersonal relations, personal conduct, and leadership potential. A score derived by summing these evaluations may range from 0 to 1,000, with no minimum qualifying score required.

5. Extracurricular Activities (ECA). Each applicant is asked to complete the Candidate Activities Record, a rather extensive form that covers participation in both athletic and non-athletic activities during high school. An objective scoring system (not empirically derived) is used to compute an Extracurricular Activities (ECA) score that ranges from 300 to 800. No minimum qualifying score is required.

6. Strong Campbell Interest Inventory (SCII). This is a vocational interest questionnaire from which scales have been constructed to predict criteria such as voluntary resignation, military aptitude rating, and choice of major (Abrahams & Neumann, 1973; Neumann & Abrahams, 1974). Two of these scales were included as predictors:

a. Career Retention Scale (CRS). The CRS comprises SCII item responses keyed to differentiate between high-tenure and low-tenure officers.

b. Engineering-Science/Humanities-Social Science Scale (ES/HSS). The SCII items are keyed on this scale to identify applicants with high interest in Engineering-Science, or high interest in Humanities-Social Sciences. Thus, individuals with high interest in either one of these Academy major areas can be identified.

Criteria

Five primary criteria were included as measures of Academy success:

1. Academic Quality Point Ratio (AQPR). The AQPR used in this study is the cumulative grade-point average earned by a midshipman after 2 years at the Academy. If the midshipman disenrolled any time within the first 2 years, his or her last available AQPR was used.

2. Military Quality Point Rating (MQPR). The MQPR is a composite rating assigned to midshipmen at the end of every semester. It is a weighted composite based on grades received in physical education, professional competency review, military performance, conduct, and in professional courses. This rating is of special importance since research conducted at the Academy (Howland, 1970) and more recently at NAVPERSRANDCEN has shown that a similar measure is related to later officer performance.

For the purpose of this research, a cumulative MQPR was computed for each midshipman, based on his or her first 2 years' ratings at the Academy. As with the AQPR, if an individual disenrolled any time within the first 2 years, the last available MQPR was used.

3. Voluntary Resignation (VOL RES). During the first 2 years, a midshipman may voluntarily withdraw from the Academy. There may be a number of reasons for this decision, such as personal or family problems, disenchantment with a naval career, or poorer performance than the midshipman is willing to tolerate. Whatever the reason, this criterion has been the least predictable of those under consideration.

4. Academic Disenrollment (ACAD). A midshipman may be discharged for failing to meet academic standards at the Academy. Currently, about seven percent of a class are separated for academic reasons.

5. All Disenrollment (ALL DIS). Since any decrease in the overall disenrollment rate would be desirable, the prediction of this criterion was examined separately. This measure includes all midshipmen who separate from the Academy either voluntarily or involuntarily, with the exception of medical discharges. The latter are not included since it seems highly unlikely that such separations would be predictable from the variables being investigated here. In the most recent graduating class (1987), about 19 percent disenrolled voluntarily or involuntarily within the first 2 years, and approximately 23 percent disenrolled by the end of the 4-year program.

Statistical Analyses

Means, standard deviations, and intercorrelations among the seven predictor variables were obtained for the 8,264 applicants to the Naval Academy classes of 1983, 1984, and 1987 for whom complete data were available on all predictors used in the current selection composite. These statistics, together with zero-order validities of seven predictors against the five criteria, were also computed for students in the Naval Academy classes of 1983, 1984, and 1987 (N = 2,835) for whom complete data were available. The resulting applicant and class data was then used to correct the zero-order validities for restriction in range. (See Guilford, 1965, p. 344, for the correction formula.)

Using the corrected validity values, multiple regression analyses were performed to obtain the optimal weighting of the seven predictors for each of the five criteria. All

predictors were evaluated against all criteria despite the fact that some of the predictors would be much more likely to predict non-academic criteria such as choice of major or career retention--criteria that will be considered in future research. Once determined, the optimal weights obtained against each criterion were combined statistically to predict an equally-weighted combination of academic performance, military performance, and disenrollment. The equations resulting from these weighting procedures were evaluated against each of the criteria using the class of 1988, and were compared to previous operational composites and to equations in which weights were adjusted to reflect judgmental criteria provided by the Academy.

RESULTS AND DISCUSSION

Applicant Data

Table 1 presents the individual predictor and Candidate Multiple intercorrelations, means, and standard deviations for the 8,264 applicants for whom all predictor scores, including average SAT, were available.

Zero-order Validities

Zero-order validities were computed for all predictors against each criterion at the end of 2 years of school for 2,835 students in the validation sample. Table 2 presents these validities as well as the predictor intercorrelations, means, and standard deviations. It is of interest to note that the average SATM is the best predictor of AQPR and ACAD DIS, while MQPR is predicted equally well by SATM and R/C. None of the individual predictors have very high validity against VOL RES or against ALL DIS. The Candidate Multiple, however, is effective against all criteria except VOL RES.

As expected, the last four non-academic predictors (RECS, ECA, ES/HSS, CRS) are not effective in predicting the essentially academic criteria. Work is continuing with these measures to improve the prediction of other criteria not presently addressed by the Candidate Multiple, such as non-academic attrition and post-Academy leadership performance.

Corrected Validities

When tests are used in selection, their statistics are often distorted by the selection process. For example, the average test score for selectees is higher than the average test score for applicants, because those with low scores are usually eliminated in the selection process. Less obviously, the validities of tests used in selection are lower in selectees than in applicants because of less variability in the scores of the selectee group. By examining corrected validities for such restriction, in range, a more accurate evaluation of how effective the different predictors are at estimating the relevant criteria is obtained. A more important reason for examining corrected validities is to see whether the relative magnitudes of the validities shift after correction. Often, the validities of operational predictors that receive the most weight are more affected by selection than are the validities of operational predictors receiving less weight. Experimental predictors (i.e., those not used to screen applicants) usually are least affected by the selection process.

Table 1

Predictor Intercorrelations, Means, and Standard Deviations (SD) for N = 8,264 Applicants to the Naval Academy Classes of 1983, 1984, and 1987 for Whom Average SAT Scores Were Available

	Intercorrelations									
	SATV	SATM	R/C	RECS	ECA	ES/HSS	CRS	CM	Mean	SD
SATV	1.000	.484	.266	.083	-.079	.049	-.037	.427	516.616	76.887
SATM	.484	1.000	.358	.092	-.082	.000	.123	.667	594.720	73.996
R/C	.266	.358	1.000	.231	.086	.008	.128	.697	544.607	111.623
RECS	.083	.092	.231	1.000	.150	-.034	.004	.526	806.711	143.237
ECA	-.079	-.082	.086	.150	1.000	-.004	.019	.129	524.392	71.216
ES/HSS	.049	.000	.008	-.034	-.004	1.000	-.036	-.020	581.759	55.711
CRS	-.037	.123	.128	.004	.109	-.036	1.000	.309	503.694	99.644
CM	.427	.667	.697	.526	.129	-.020	.309	1.000	60229.514	5126.462

Note. Since the CM equations used operationally for the 1983, 1984, and 1987 classes differed only slightly from each other, the operational values for each year group were combined and treated as a single CM variable.

Table 2

Predictor Intercorrelations, Means, Standard Deviations (SD) and Validities for N = 2,835 Students in the Naval Academy Classes of 1983, 1984, and 1987

	SATV	SATM	R/C	RECS	ECA	ES/HSS	CRS	CM	Mean	SD
Intercorrelations										
SATV	1.000	.434	.248	-.110	-.080	.043	.008	.409	530.451	74.323
SATM	.434	1.000	.347	-.233	-.125	.031	.168	.639	619.422	68.585
R/C	.248	.347	1.000	-.170	.032	.009	.132	.687	579.535	106.360
RECS	-.110	-.233	-.170	1.000	.092	-.008	-.177	.017	884.624	98.810
ECA	-.080	-.124	.032	.092	1.000	-.008	-.008	.060	529.343	69.540
ES/HSS	.043	.031	.009	-.008	.008	1.000	.002	.017	579.788	54.419
CRS	.008	.168	.132	-.177	-.008	.002	1.000	.312	517.372	95.276
CM	.409	.639	.687	.017	.060	.017	.312	1.000	63537.430	3497.104
Validities										
AQPR	.360	.502	.442	-.056	-.026	.007	.100	.523	2.614	.542
MQPR	.282	.354	.352	.007	.040	-.008	.082	.425	2.954	.458
VOL RES	.006	-.024	-.025	.004	.055	-.035	.075	.023	.104	.306
ALL DIS	.084	.121	.100	-.013	.044	-.025	.062	.147	.153	.360
ACAD DIS	.205	.365	.289	-.046	.048	-.024	.018	.339	.052	.222

Notes.

1. AQPR and MQPR coefficients are Pearson correlations.

2. VOL RES, ALL DIS, and ACAD DIS coefficients are biserial correlations.

3. Signs of the validity coefficients for the VOL RES, ALL DIS, and ACAD DIS criteria were reversed so that positive coefficients indicate variables which are associated with remaining in the program.

4. Since the CM equations used operationally for the 1983, 1984, and 1987 classes differed only slightly from each other, the operational values for each year group were combined and treated as a single CM variable.

5. Validities of at least .04 are significant at the .05 level; those of at least .05 are significant at the .01 level.

Table 3 presents the corrected and uncorrected validities of the individual predictors against all five criteria for the validation samples. As expected, the corrected validities are generally higher than the uncorrected validities, especially for the academic predictors and criteria. However, there was no major shift in the order of the corrected validities.

Composite Validities

The corrected validities and intercorrelations based on the 1983, 1984, and 1987 classes presented in in Tables 2 and 3 were used to develop several experimental candidate multiple composites, one of which was modified slightly by the Academy and implemented operationally as the Candidate Multiple for the class of 1990 (CM90). The experimental Candidate Multiples (CM90A, CM90B, CM90C, CM90D) and the operational Candidate Multiples for the classes of 1990, 1989, and 1988 (CM(), CM89, CM88), were cross-validated on selectees from the Academy class of 1988. These validity data are presented in Table 4.

CM90A. In the first experimental Candidate Multiple, CM90A, the predictor variables were weighted optimally to predict the equally-weighted sum of three criteria: AQPR, MQPR, and ALL DIS (all disenrollment). ALL DIS was included so that any predictable variance in academic, honor or conduct discharges or in voluntary resignations would be captured in the least squares regression process. CM90A represents the maximum attainable validity against the composite criterion for a weighted sum of the selection instruments as they are presently scored. Although this optimal weighting failed to predict two criteria of interest to the Academy (i.e., VOL RES and ALL DIS), it did provide a standard against which to measure other experimental candidate multiple weightings.

CM90B. The second experimental Candidate Multiple, CM90B, examined the optimal weighting of the last five predictors under the constraint that SATV and SATM would obtain equal weight. The equal weighting of SATV and SATM reflected the Academy's desire to obtain a composite that did not unduly favor engineering- and science-related abilities and propensities over their Humanities-related counterparts. It can be seen that this weighting results in slightly lower validities for AQPR and ACAD DIS. These reductions, although statistically significant, are of little practical consequence.

CM90C. The third experimental composite, CM90C, maintained a set of weights specified by the Academy (and shown in Table 4) for the last four predictors and allowed the weights for SATV, SATM, and R/C to vary freely. This experimental composite had validities almost equal to those attained by the optimal composite (CM90A), but SATM received more than twice the weight of SATV. While CM90C had acceptable validities, the resulting optimal weights for SATV and SATM did not meet the requirement of treating humanities- and engineering/sciences-related abilities and propensities equally.

CM90D. The fourth experimental composite, CM90D, maintained both the Academy-specified weights for the last four predictors and equal weights for SATV and SATM. With these restrictions, the relative weights of SATV, SATM, and R/C were chosen to optimize the validities. This fourth experimental composite was slightly less valid than the other three composites for predicting AQPR and ACAD DIS, but maintained desirable relative weights for all variables.

Table 3

Corrected and Uncorrected Validities for the
1983, 1984, and 1987 USNA Classes

	Corrected Validities					Uncorrected Validities				
	AQPR	MQPR	VOL RES	ALL DIS	ACAD DIS	AQPR	MQPR	VOL RES	ALL DIS	ACAD DIS
SATV	.45	.37	.01	.13	.29	.36	.28	.01	.08	.21
SATM	.62	.48	-.01	.18	.47	.50	.35	-.02	.12	.37
R/C	.58	.49	-.01	.16	.41	.44	.35	-.03	.10	.29
RECS	-.04	.01	.00	-.01	-.04	-.06	.01	.00	-.01	-.05
ECA	.02	.08	.06	.06	.08	-.03	.04	.06	.04	.05
ES/HSS	.00	-.01	-.03	-.03	-.02	.01	-.01	-.03	-.03	-.02
CRS	.20	.17	.08	.10	.09	.10	.08	.08	.06	.02

Notes.

1. AQPR and MQPR coefficients are Pearson correlations.

2. VOL RES, ALL DIS, and ACAD DIS coefficients are biserial correlations.

3. Signs of the validity coefficients for the VOL RES, ALL DIS, and ACAD DIS criteria were reversed so that positive coefficients indicate variables associated with remaining in the program.

4. Validities of at least .04 are significant at the .05 level; those of at least .05 are significant at the .01 level.

Table 4

Cross-Validation of Experimental, Operational, and Current Selection Composites
on the USNA Class of 1988 at the End of Plebe Year

		Effective Weights							Uncorrected Validities					Corrected Validities				
Type	Equation	SATV	SATM	R/C	RECS	ECA	ES/ HSS	CRS	AOPR	MOPR	VOL RES	ALL DIS	ACAD DIS	AOPR	MOPR	VOL RES	ALL DIS	ACAD DIS
Experimental	CM90A	15	29	27	10	5	6	8	.52	.34	-.10	-.01	.30	.64	.43	-.13	-.02	.39
	CM90B	19	19	29	10	6	8	9	.51	.34	-.10	-.01	.28	.63	.43	-.13	-.02	.38
	CM90C	12	25	25	10	6	10	12	.51	.34	-.10	-.01	.28	.63	.43	-.13	-.01	.38
	CM90D	17	17	28	10	6	10	12	.50	.34	-.10	-.01	.27	.62	.43	-.13	-.02	.37
Previous Operational	CM89	14	19	22	8	3	14	20	.47	.31	-.09	-.02	.23	.60	.41	-.12	-.03	.34
	CM88	9	23	22	8	3	16	19	.45	.29	-.06	.00	.24	.58	.40	-.10	-.01	.35
Current Operational	CM90	18	18	26	10	6	10	12	.50	.34	-.10	-.01	.27	.62	.43	-.13	-.02	.37

Notes.

1. CMA90A-all variables are optimally weighted.
2. CM90B and CM90D-SAT-Verbal and SAT-Math are weighted equally.
3. CM90C and CM90D-Variables RECS, ECA, ES/HSS, and CRS were entered into regression with pre-determined weights.
4. Signs of the validity coefficients for the VOL RES, ALL DIS, and ACAD DIS criteria were reversed so that positive coefficients indicate variables associated with remaining in the program.
5. Validities of at least .04 are significant at the .05 level; those of at least .05 are significant at the .01 level.

CM90. The operational composite, CM90, was developed in collaboration with Academy officials so as to consider criteria other than those for which objective information was readily available. This operational weighting gives slightly greater weight to SAT than does CM90D while weighting SATV and SATM equally. At the same time, it maintains the relative weights desired by the Academy for the last four predictors. This operational composite is just as valid as CM90D in the cross-validation sample, while giving the desired emphasis to SAT.

The weights for CM88 and CM89, presented in Table 4, show the increasing emphasis over time on the verbal component of SAT. It can also be seen that the current operational composite, CM90, continues this progressive emphasis without sacrificing validity. In fact, CM90 has significantly higher validity than either CM88 or CM89 for predicting most criteria in the 1988 sample. These results suggest that validity will not be sacrificed, and may even be improved, in reaching the Academy's goals.

CONCLUSIONS AND RECOMMENDATIONS

All four of the experimental composites improved on the prediction of AQPR, MQPR, and academic disenrollment when compared to previous operational composites. Improvement was slightly greater for the academic criteria when all variables were free to assume empirically-determined weights, and decreased as more constraints were placed on the empirical weighting process.

Based on these results, it is recommended that the predictor weights used in the Candidate Multiple be modified to reflect the weights empirically derived in this research. (The Academy did, in fact, adopt a modification of one of the experimental composites for use with the class of 1990.) It is also recommended that research continue to expand the range of criteria that can be predicted by the Candidate Multiple.

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