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A COMPARISON BETWEEN THE ARMED SERVICES VOCATIONAL APTITUDE BATTERY AND THE NAVY BASIC TEST BATTERY IN PREDICTING NAVY SCHOOL PERFORMANCE

Patricia J. Thomas

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Submitted by

B. Rimland, Ph.D., Director, Personnel Measurement Research Department

Approved by

E. E. Dudek, Ph.D., Technical Director
Karl E. Kuehner, Commander, USN
Commanding Officer

Naval Personnel and Training Research Laboratory
San Diego, California 92152

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SUMMARY AND CONCLUSIONS

A. Background and Problem

The Armed Services Vocational Aptitude Battery (ASVAB) was developed by a joint-service technical working group, using items from the services' previously operational tests. The ASVAB was designed to replace the Armed Forces Qualification Test, the selection test used to determine qualifications for all of the services. It was also to be a potential replacement for the separate classification batteries used by each of the services. The advantages of a common service battery are at least partially offset by certain problems--particularly those posed by the unique jobs within each service and the differences in the available manpower pools. Thus, the effectiveness of the ASVAB as a classification tool for Navy use needed to be determined and compared with that of the Navy Basic Test Battery (BTB).

B. Approach

The ASVAB was administered to over 47,000 recruits at the Naval Training Centers in San Diego and Great Lakes in fiscal year 1968. The men in the original sample who subsequently attended a Navy Class "A" school were identified and their BTB scores and final school grades obtained. The validities of the ASVAB and the BTB tests were investigated within each service school having at least 50 students who had taken the ASVAB. Linear-sum correlations were also computed to determine the best combinations of ASVAB tests for use as possible school selectors.

A computerized item selection technique, Program SEQUIN, was applied to each of the tests from both batteries, using a combined school sample of 900 men. Various item statistics and validities and reliabilities for shortened tests were obtained for use in evaluating Form 1 of the ASVAB and in the development of subsequent forms of the ASVAB.

C. Findings and Conclusions

Form 1 of the ASVAB was found to be too easy for effective discrimination among Navy school students (page 5). Comparisons of the BTB and the ASVAB validities uniformly favored the BTB (page 7). The linear-sum validity analysis of possible ASVAB classification composites revealed excessive dependence on the ASVAB Arithmetic Reasoning Test, making selection within a limited talent pool very difficult (page 7). The SEQUIN analysis demonstrated that by selecting only the most valid items from either the ASVAB or the BTB, short instruments of greater validity could result (page 9).

D. Recommendations

It was recommended that: (1) subsequent forms of the ASVAB be made more difficult (page 10); (2) ASVAB validities for predicting school performance in the other services be determined (page 11); and (3) the effectiveness of the ASVAB for differential classification be improved (page 11).

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CONTENTS

TABLES

A COMPARISON BETWEEN THE ARMED SERVICES VOCATIONAL APTITUDE BATTERY AND THE NAVY BASIC TEST BATTERY IN PREDICTING NAVY SCHOOL PERFORMANCE

A. INTRODUCTION

1. Background

The Armed Services Vocational Aptitude Battery (ASVAB) was developed in response to a directive from the Department of Defense that a joint-service aptitude battery be constructed. The Army Behavioral Science Research Laboratory was directed to coordinate the test development efforts of all the services and perform statistical analyses on cross-service data.

The ASVAB was designed to replace both the Armed Forces Qualification Test (AFQT), which is used to determine the mental levels of men prior to conscription or enlistment, and the separate classification batteries used by the services in assigning men to training schools and jobs. The first use designated for the ASVAB was as a replacement for the Airman Qualifying Examination, which was being administered in high schools by the Air Force as a recruiting and classification device (Vitola & Alley, 1968). ASVAB scores derived from high school testing were to be made available to all services.

With these purposes in mind, a joint-service technical working group met in early 1966 to design procedures for selecting and constructing the subtests that would be included in the ASVAB. The resulting plan went into effect in April of 1966, when 3,300 recruits, representing men from all of the services, were given the complete Army, Air Force, and Navy classification batteries (25 tests in all). Using this cross-service sample, intercorrelations among the tests were computed and corrected for restriction on the AFQT and for test-retest reliability (Bayroff & Fuchs, 1968). Tests of similar content which correlated .90 or above (after correction) were considered sufficiently comparable to be substituted for each other. In this manner, eight different groups of tests were identified. For each group an ASVAB test of 25 items was assembled from existing item pools provided by the Army, Navy, and Air Force. These items had been used in previously operational tests in the services. The resulting eight tests were titled Word Knowledge, Arithmetic Reasoning, Tool Knowledge, Spatial Perception, Mechanical Comprehension, Shop Information, Automotive Information, and Electronic Information. The clerical tests from each of the service batteries were not correlated enough to be considered interchangeable. On the basis of previous Navy research comparing validities of various clerical tests (Curtis, 1965), the Army Coding Speed Test was selected for inclusion in the ASVAB.

Each service administered the newly developed ASVAB to samples of its own recruits in the summer of 1967. Tables for converting ASVAB scores to corresponding test scores within each of the service classification batteries were developed by the equi-percentile method. Thus, the ASVAB could be used in counseling students prior to enlistment as to their eligibility for assignment and training for specific occupational groups within each of the services.

2. Problem

While a common service battery could result in certain economies and provide an equal opportunity for all of the services to recruit in high school testing programs, the possibility of using a single battery for the assessment of aptitude in the entire recruit population remained an open question. Certain classification problems are posed by a common battery: (1) the manpower pool available to each of the services is not equally talented; (2) unique jobs not found in the other branches exist within each of the services; and (3) similarly titled occupations may require quite different training. In the case of the Navy, a real problem was whether the ASVAB could do as effective a job as the Navy Basic Test Battery (BTB).

The effectiveness of a Navy aptitude test is typically assessed by computing its correlations with training school performance. These validities have recently been determined for the current form of the BTB (Thomas & Thomas, 1967) and could be used as a yardstick for evaluating the ASVAB.

B. PROCEDURE

1. Sample

The ASVAB was administered to over 47,000 recruits at the Naval Training Centers in San Diego and Great Lakes during fiscal year 1968. The service numbers of the men taking the ASVAB were matched with those on the Class "A" school data tapes to identify school trained men and to obtain school performance information as a criterion measure. This step reduced the sample to 19,681 men.

2. Variables

a. Armed Services Vocational Aptitude Battery (ASVAB)--eight tests of 25 items each: Word Knowledge (WK), Arithmetic Reasoning (AR), Tool Knowledge (TK), Spatial Perception (SP), Mechanical Comprehension (MC), Shop Information (SI), Automotive Information (AI), and Electronic Information (EI). The ninth test in the battery, the Coding Speed Test was not given because of time limitations and the prior availability of

recent validity data for this test on Navy school samples (Curtis, 1965). Each test is separately timed and scored.[1]

b. Navy Basic Test Battery (BTB)--five separately timed tests of varying length: General Classification Test (GCT), Arithmetic Reasoning Test (ARI), Mechanical Test (MECH), Clerical Test (CLER), and Shop Practices (SP). Also included was a special Navy classification test, the Electronics Technician Selection Test (ETST), which supplements the BTB.

c. Final School Grade (FSG)--a mark on a scale of 00-99 assigned at the time of graduation or disenrollment from a Class "A" school. A grade of 63 is the minimum passing mark in most schools.

3. Treatment of Data

Means, standard deviations, and intercorrelations of the eight ASVAB tests were computed, using the total preliminary sample of Navy recruits taking the battery. These statistics were used to obtain estimates of the unrestricted range of Navy talent for matrix corrections.

The sample of men for whom school grades were available (N = 19,681) was divided into Class "A" school samples. Each school having both predictor and criterion data for at least 50 students was analyzed separately. For each of the 47 resulting school samples, zero-order, linear-sum, and multiple correlations were computed and corrected for restriction in range. In addition, final school grades for each school were converted to standard scores having a mean of 50 and a standard deviation of 10. Using this criterion, uncorrected and corrected validities for the combined student sample were determined.

A subsample of 900 men from the combined student sample was chosen for item analysis of the 200 ASVAB items. Program SEQUIN (Moonan & Pooch, 1966), a computerized item analysis program, was applied to each ASVAB test separately to produce item difficulties and point-biserial correlations with standardized FSG and to sequence the items in such a manner that the cumulative correlation increased maximally with the addition of each item. Similar item analyses of the BTB were also performed for 900 students who had gone through recruit training at San Diego for comparison with the ASVAB.[2]

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[1]For counseling purposes with high school examinees, unweighted sums of ASVAB test scores are converted to approximate the selection score composites of each of the service batteries.

[2]During the period of ASVAB administration, classification test scoring was not computerized at the Great Lakes Naval Training Center, so BTB item responses were not available for these recruits.

The distribution of p values for the items in each of the ASVAB tests was determined separately for a subsample of approximately 1,100 men from two of the Naval Training Centers. This analysis was conducted in addition to the above item analysis because it was felt that using a school sample yielded biased item difficulty values.

C. RESULTS AND DISCUSSION

1. Statistical Characteristics of the ASVAB

Means, standard deviations, and intercorrelations among the eight ASVAB tests, using a Navy recruit population, are presented in Table 1. It is evident from the test means that this group found the 25-item ASVAB tests relatively easy, particularly the Word Knowledge Test. Table 2 shows the distribution of difficulty values of the items in each of the tests for a subsample of 2,274 recruits. Maximum discrimination is

TABLE 1

Intercorrelations Among ASVAB Tests for a Navy Recruit Population (N=47,360)

Test	1	2	3	4	5	6	7	8
1 Word Knowledge	--	.65	.20	.46	.52	.46	.44	.58
2 Arithmetic Reasoning	.65	--	.21	.54	.53	.40	.40	.53
3 Tool Knowledge	.20	.21	--	.37	.45	.65	.66	.49
4 Spatial Perception	.46	.54	.37	--	.56	.44	.41	.49
5 Mechanical Comprehension	.52	.53	.45	.56	--	.56	.55	.60
6 Shop Information	.46	.40	.65	.44	.56	--	.68	.62
7 Automotive Information	.44	.40	.66	.41	.55	.68	--	.62
8 Electronic Information	.58	.53	.49	.49	.60	.62	.62	--
Mean	20.60	17.88	18.09	17.48	17.48	17.18	16.64	17.51
Standard Deviation	4.26	4.71	3.85	4.13	3.42	3.60	5.03	3.89

TABLE 2

Frequency Distributions of p Values of Form 1 ASVAB Items for an Unrestricted Sample of Navy Recruits (N=2,274)

Test	Number of items within each p value range[a]								Mean p value of test
	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	
WK	1	1			2	2	9	10	.82
AR		2	4	1	5	3	4	6	.71
TK		3	5		2	3	4	8	.73
SP	1	5	1		2	4	7	5	.70
MC	1	3		3	5	2	4	7	.70
SI		4	3	3	2	2	2	9	.69
AI	1	1	4	4	3	3	6	3	.67
EI	1	3	4		1	3	6	7	.69
Total	5	22	21	11	22	22	42	55	.71

[a]Decimal points which designate the p value range have been omitted from the column headings.

obtained by items with p values of about .50 to .60. The mean ASVAB test item difficulties ranged from .67 to .82, and few of the items had p values in the .50-.59 range. Apart from the high test means, the relatively small standard deviations indicate a restricted range of test scores for Navy recruits. Thus, the discriminatory capability of the battery for Navy use is necessarily limited.

2. ASVAB and BTB Test Validities

Table 3 presents the validities for the ASVAB and the BTB tests for the combined school sample.[3] The product-moment, multiple, and linear-sum correlations between test scores and school grades were corrected for restriction in range. For the ASVAB, 247 linear-sum test combinations were correlated with the criterion to arrive at the best selector

[3]Correlation matrices for each of the 47 schools are available from the author for those interested in the intercorrelations among variables within each school.

TABLE 3

Comparative Statistics for the ASVAB and BTB Tests Against a Standardized Final School Grade Criterion for a Combined School Sample (N=18,313 from 47 Schools)

ASVAB											BTB		
Test	Intercorrelations								Validity		Test	Validity	
	WK	AR	TK	SP	MC	SI	AI	EI	r	r_c		r	r_c
WK	--	.55	.23	.39	.43	.36	.38	.51	.22	.29	GCT	.35	.45
AR		--	.16	.45	.42	.27	.31	.43	.35	.42	ARI	.37	.47
TK			--	.34	.44	.69	.69	.51	.12	.15	MECH	.22	.31
SP				--	.49	.37	.35	.42	.23	.30			
MC					--	.49	.50	.55	.28	.35	MECH	.22	.31
SI						--	.65	.58	.19	.26	SHOP	.24	.33
AI							--	.59	.19	.25			
EI								--	.30	.36	ETST	.45	.55
Mean	22.15	19.85	18.87	19.05	18.74	18.27	18.11	18.92	R = .40			R = .48	
S.D.	3.07	3.86	3.70	3.48	2.96	3.29	4.71	3.55	R_c = .47			R_c = .57	
Beta	-.0636	.2582	-.0755	.0277	.1082	.0333	-.0018	.1716					

Four Best ASVAB Linear Composites			Four Best BTB Linear Composites		
Composite	r	r_c	Composite	r	r_c
AR+EI	.39	.45	ARI+ETST	.46	.56
AR+MC	.38	.45	GCT+ETST	.44	.54
AR+SI	.35	.42	ETST+SHOP	.42	.52
AR+SP	.35	.42	MECH+ETST	.41	.52

test composites. Only the highest linear-sum correlations for pairs of tests are presented in the table, since no combination of three or more tests added more than .03 corrected validity points to the two-test linear sums.

An expedient method for comparing the validities of the ASVAB and the BTB is provided in Table 3, which contains the results of the analysis of the combined data from all 47 schools. From an examination of the multiple correlations, it is readily apparent that the BTB is a significantly more valid test battery than the ASVAB for a Navy school population. The corrected multiple correlations against the standardized combined school grade criterion were .57 and .47 respectively for the BTB and the ASVAB ($p < .01$). Among the individual tests, GCT and ETST had significantly higher validities (at the .01 level) than did Word Knowledge and Electronic Information. Because the BTB MECH contains both tool knowledge and mechanical comprehension items, it was compared to two ASVAB tests and found to be significantly more valid than one and slightly less valid than the other. The linear-sum validities of the BTB were also higher than were those for the ASVAB. Both batteries have a single subtest which appears in all of the linear sums in Table 3 (Arithmetic Reasoning in the ASVAB and Electronics Technician Selection Test in the BTB) and is the best single predictor of final school grade.

A minimum number of composites, each applicable to a group of related occupational ratings, is desired for classification purposes. To achieve this, the 47 schools were clustered on the basis that one of the schools' four best ASVAB linear-sum correlations was also appropriate for similar schools.[4] In this manner, four selection composites were identified: Arithmetic Reasoning + Electronic Information, Word Knowledge + Arithmetic Reasoning, Arithmetic Reasoning + Mechanical Comprehension, and Arithmetic Reasoning + Shop Information. Unfortunately the Arithmetic Reasoning Test appears in all the composites; therefore, differential classification cannot be maximized. Composites containing different and unrelated tests would allow a larger proportion of the recruit sample to score above the mean in at least one area. In contrast, when the schools are clustered on the basis of the best BTB composites, no single test is dominant. GCT, ARI, and ETST are included in more than one composite (see Table 4 in the Appendix).

Table 5 presents the best composites for 41 schools, representing 31 different Navy ratings. An unexpected finding was the validity of AR + EI in the prediction of school performance for four of the mechanical ratings. The best BTB composite for these ratings is GCT + MECH, measures of verbal and mechanical abilities, which would logically be related to grades in mechanical schools.

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[4]One school, Utilitiesman, seemed unrelated to the group of ratings with which it was initially clustered. At a loss of only .03 correlation points, the fifth best linear sum was chosen as the best selection composite for Utilitiesman, placing it with other similar ratings.

TABLE 5

Best ASVAB Selection Composites for 31
Navy Ratings at 41 Schools

ASVAB Composite	Rating
I. AR+EI	Electrician's Mate
	Aviation Electrician's Mate
	Construction Electrician
	Electronics Technician
	Aviation Electronics Technician
	Aviation Fire Control Technician
	Machinist's Mate
	Aviation Machinist's Mate
	Engineman
	Aviation Structural Mechanic
II. WK+AR	Communications Technician (Communications)
	Communications Yeoman
	Dental Technician
	Hospital Corpsman
	Quartermaster
	Radarman
	Radioman
	Steward
	Storekeeper
	Yeoman
III. AR+MC	Aviation Ordnanceman
	Communications Technician (Collection and Technical)
	Signalman
	Sonar Technician (Surface)
	Torpedoman's Mate
IV. AR+SI	Air Controlman
	Boilerman
	Builder
	Damage Controlman
	Shipfitter
	Utilitiesman

Note.--Not all 47 schools are included because five of the schools prepare men for training in several ratings and another school (Steelworker) did not have any of the ASVAB composites among its four best linear sums. Only 31 ratings are represented among the 41 remaining schools because training for some ratings occurs at more than one location.

The Tool Knowledge Test of the ASVAB appears to be only slightly related to performance in Navy schools. Its corrected validity across all schools was .15 and it was included in only six of the 188 best linear-sum predictors. This test also correlated highly with two other tests in the ASVAB (.69 with both Shop Information and Automotive Information), which suggests that these three tests are evaluating much of the same information and that the overall validity of the battery in Navy schools would not suffer if the Tool Knowledge Test were eliminated.

3. Shortened Test Validities

A summary of the results of Program SEQUIN, applied to both the ASVAB and the BTB, is presented in Table 6. As anticipated from previous SEQUIN research (Swanson & Rimland, 1970), all of the shortened test validities are from .03 to .15 correlation points higher than those found for the full length tests. In order to obtain these increases the items which did not contribute to the tests' validities were not scored, effectively resulting in a 53 percent reduction in the ASVAB and a 67 percent reduction in the length of the BTB. These results would have to hold up under cross-validation, of course, before such extreme reductions could be recommended. In addition, somewhat longer tests would be considered in order to increase reliability.

The real value of the SEQUIN analyses lies in their possible application to test construction. Two new forms of the ASVAB are currently being built. The SEQUIN analysis shows that there are some very good items in the operational ASVAB. The inclusion of these items in the new forms of the battery is strongly indicated as a means of producing instruments of greater validity.

D. CONCLUSIONS AND RECOMMENDATIONS

The Basic Test Battery was shown to be better than the ASVAB as a classification battery for Navy recruits. Although the validities reported for the ASVAB were higher than the BTB in a few schools, the analyses of samples taken from all the schools consistently favored the BTB. This situation could change when Form 1 of the ASVAB is superseded, provided the two new forms are a substantial improvement over Form 1.

The results of this study can contribute to the efficacy of the revised ASVAB tests now being constructed. It has been shown that several of the tests in the current battery have almost no items sufficiently difficult for effective discrimination among the more talented men. This was especially true of the Word Knowledge Test. Also, it appears that the battery could be shortened with an increase in validity. Items with negative or low point-biserial correlations with the criteria should be discarded. The Tool Knowledge Test could be eliminated with no loss in the effectiveness of the battery with respect to Navy school populations. Since Form 1 of the ASVAB will become obsolete when the new forms are made

TABLE 6

Summary Validity and Reliability Statistics from Program SEQUIN Item Analysis; Criterion: Standardized Final School Grade (N=900)

Test and Source	No. Items in Total Test	No. of Items Yielding Maximum Validity	Full Test Validity	Short Test Validity	Short Test Reliability
GCT (BTB)	100	28	.35	.47	.79
WK (ASVAB)	25	14	.22	.32	.58
ARI (BTB)	30	16	.37	.44	.75
AR (ASVAB)	25	16	.35	.43	.70
MECH (BTB)	100	24	.22	.37	.66
MC (ASVAB)	15	25	.28	.34	.57
TK (ASVAB)	25	7	.12	.15	.52
ETST (BTB)	70	28	.45	.52	.75
EI (ASVAB)	25	12	.30	.37	.57
SHOP (BTB)	30	12	.24	.34	.57
SI (ASVAB)	25	7	.19	.24	.39
SP (ASVAB)	25	16	.23	.29	.61
AI (ASVAB)	25	10	.19	.23	.67

operational, serious consideration should be given to the incorporation of the best items from Form 1 into Forms 2 and 3. Inclusion of these items would help to insure effectiveness of the new tests.

From the foregoing analyses it is recommended that:

1. The Navy BTB be retained for recruit classification until the effectiveness of the new forms of the ASVAB can be demonstrated to be equal to that of the BTB.

2. The difficulty level of the Word Knowledge Test be increased in the new forms of the ASVAB by including more items with $\bar{p}$ values in the .40 to .70 range. Also, the test means and standard deviations obtained with Army, Air Force, and Marine Corps populations be reviewed to determine whether the difficulty levels of the other tests are adequate in those services.

3. Program SEQUIN item data from the Navy school population be used in the selection of items for the new forms of the ASVAB.

4. The ASVAB subtests be evaluated with school populations from the other services to determine whether these tests are effective selection instruments, as compared with existing batteries.

5. The classification effectiveness of the ASVAB be studied in addition to the predictive effectiveness analysis presented here. The dependence upon Arithmetic Reasoning in all of the classification composites is a severe weakness of Form 1 of the ASVAB and would present serious problems whenever the talent of the manpower pool is limited.

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APPENDIX

TABLE 4

Best BTB Selection Composites for 32
Navy Ratings at 41 Schools

	BTB Composite	Rating
I.	ARI+ETST	Aviation Electronics Technician Aviation Fire Control Technician Communications Technician (Collection and Technical) Electronics Technician Signalman Sonar Technician (Surface) Torpedoman's Mate
II.	GCT+ARI	Air Controlman Communications Technician (Communications) Communications Yeoman Dental Technician Hospital Corpsman Quartermaster Radarman Radioman Steward Storekeeper Yeoman
III.	GCT+ETST	Aviation Electrician's Mate Aviation Structural Mechanic Construction Electrician Damage Controlman Electrician's Mate Engineman Machinist's Mate
IV.	ARI+MECH	Aviation Machinist's Mate Aviation Ordnanceman Boilerman Builder Shipfitter Steelworker Utilitiesman

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13. ABSTRACT

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