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(6) REVIEW OF RESEARCH ON PREDICTING PERFORMANCE OF WOMEN IN ELECTRICAL AND MECHANICAL WORK.

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REVIEW OF RESEARCH ON PREDICTING PERFORMANCE OF WOMEN IN ELECTRICAL AND MECHANICAL WORK

Under the Army Research and Development Task "Utilization of Women and Physically Limited Personnel," one objective is the establishment of procedures specifically designed to identify WAC enlisted personnel with technical aptitude appropriate for assignment to courses and jobs in mechanical and electrical occupational areas. The Army aptitude area system of classification employs information tests as the major components of the selector composites for the areas: Electronics Information Test (ELI) for the Electronics and Electrical Maintenance areas, Shop Mechanics Test (SM) for Precision Maintenance and Military Crafts areas, and Automotive Information Test (AI) for the Motor Maintenance Area. The relatively low scores of enlisted women on these information tests raise serious questions, not only as to the limitation on variability and thus on reliability and validity of such measures for WAC personnel, but also as to the usefulness of such tests in identifying all the potential ability resources of enlisted women in these technical areas. The American culture tends to give most boys an opportunity to develop mechanical and electrical knowledge if their interests and aptitude so incline, but far less opportunity of this kind is afforded to girls. In utilizing WAC enlisted personnel, failure to discover potential in technical areas is a more likely type of error than that of selecting "false positives". Consequently, the discovery or construction of predictor measures other than the standard information tests for EM is an important phase of the task effort. The first step in this phase, a review of the more pertinent research by other services, by the British Armed Forces, and by civilian industrial firms, is the subject of this report.

PROCEDURE

The procedure employed was, first, to examine the psychological literature from World War II to the present for research studies dealing with measures used to select women for electrical and mechanical jobs. The "factor domain" to which each test belongs was then determined, following the classification presented by French (7). Considering factors as dimensions of aptitudes which stand in relatively simple relationships to known and presently measurable psychological phenomena, identification of factors pertinent to success in a given area would provide a basis upon which new selection requirements for a particular job might be constructed. In evaluating the validity of instruments for a given purpose, specific factors as well as "factor domains" would need to be considered. For example, the differences in validity coefficients found in the present survey for tests grouped under the mechanical experience factor appeared to be accounted for by the specific factors involved.

SELECTION OF RESEARCH STUDIES FOR REVIEW

Several limitations were imposed on the selection of research studies to be included in the survey. First, the reports had to be concerned with validity. This limitation excluded a considerable number of studies containing only normative data. Secondly, the reports had to deal with electrical and mechanical jobs that were comparable to, or related to, a type of work likely to be encountered in Army jobs. It would have been highly desirable to limit the survey to studies presenting data on separate samples of men and women tested and evaluated under similar conditions. However, few such studies were found. In the introduction to an extensive review of selection and classification procedures for women, Wand and Mollenkopf (9) stated that very few studies could be found in which men and women were administered the same tests, assigned the same work, and evaluated in the same manner. The desired limitation was therefore not imposed. Similar considerations prompted the decision not to established a rigid minimum on the size of sample. In some cases the smallness of a sample was overlooked if the study was otherwise conducted in a sound fashion and was concerned with instruments of potential value and criterion measures of performance related to duties found in corresponding MOS.

RESULTS

Too few relevant studies were found to permit positive identification of the factors or tests most effective for predicting the performance of women in electrical and mechanical maintenance jobs. The survey provided only indications of types of selection instrument meriting further consideration.

Reports dealing with the effectiveness of selected tests in predicting performance in the electronic and electrical maintenance occupational areas are summarized in Table 1. Table 2 summarizes validation studies for the precision and motor maintenance occupational areas. The tests considered have been classified into ten factor domains. In Table 2, two tests are included which overlap two factor domains. In addition to providing validity data, the tables provide information on sample size, the subjects, the training on job for which selection was made, the criterion measure, and finally, the number of the reference in which the study was reported. Where data were available for men and women tested and evaluated under similar conditions, statistics for the two samples are presented separately.

The factor which appeared most appropriate to the selection of women for electrical and mechanical jobs were number facility, induction, and speed of symbol discrimination. Other factors -- general reasoning, visualization, spatial relations, verbal

Table 1

VALIDITY COEFFICIENTS IN THE ELECTRONIC AND ELECTRICAL MAINTENANCE AND REPAIR AREA

Test	Factor Domain	Sample	Training or Job	Criterion	r_{xy} [b]	Reference
Cooperative Mathematics Test	Number Facility	86 Women	Electronic orientation	Grade Point Average	.55	(3)
A.T.S. Arithmetic	Number Facility	72 A.T.S. Women	Electrician training	a	.56	(10)
Air Force Numerical Operations	Number Facility	56 WAF	Radio Mech.	Final Course Grade	.34	
		513 Airmen	training		.37	(6)
Progressive Matrices	Induction	72 A.T.S. Women	Electrician training	a	.64	(10)
Air Force Dial and Table Reading	Speed of Symbol Discrimination	56 WAF	Radio Mech.	Final Course Grade	.52	
		513 Airmen	training		.57	(6)
Air Force Speed of Identification	Speed of Symbol Discrimination	56 WAF	Radio Mech.	Final Course Grade	.37	
		513 Airmen	training		.32	(6)
Wonderlic Personnel Test	General Reasoning	86 Women	Electronic orientation	Grade Point Average	.50	(3)
Air Force Arithmetic Reasoning	General Reasoning	56 WAF	Radio Mech.	Final Course Grade	.57	
		513 Airmen	training		.60	(6)
Air Force Mechanical Principles	General Reasoning	56 WAF	Radio Mech.	Final Course Grade	.33	
		513 Airmen	training		.53	(6)
Squares	Visualization	72 A.T.S. Women	Electronic training	a	.51	(10)
Air Force Word Knowledge	Verbal Knowledge	56 WAF	Radio Mech.	Final Course Grade	.36	
		513 Airmen	training		.46	(6)
Air Force Mechanical Key (Biographical Inventory)	Mechanical Experience	56 WAF	Radio Mech.	Final Course Grade	.09	
		513 Airmen	training		.47	(6)
Air Force Electrical Information	Mechanical Experience	56 WAF	Radio Mech.	Final Course Grade	.56	
		513 Airmen	training		.62	(6)
Air Force Tool Functions	Mechanical Experience	56 WAF	Radio Mech.	Final Course Grade	.08	
		513 Airmen	training		.37	(6)

[a] It is not clear as to the exact assessment used. Principally, there were four criteria; rank ratings, examination mark, ratings of skill, and measures of skill. Same combination of these assessments was used as the criterion of success in training.

[b] [illegible]

Table 2

VALIDITY COEFFICIENTS IN THE PRECISION AND MOTOR MAINTENANCE AND REPAIR AREA

Test	Factor Domain	Sample	Training or Job	Criterion Measure	r_{xy} [b]	Reference
A.T.S. Arithmetic Test	Number Facility	36 ATS	Instrument Mech. Trng.	a	.76	(10)
Progressive Matrices	Induction	36 ATS	Instrument Mech. Trng.	a	.58	(10)
		41 ATS	Driver Mech. Trng.	a	.78	
Instructions Test	Speed of Symbol Discrimination	36 ATS	Instrument Mech. Trng.	a	.68	(10)
Bennett Test of Mechanical Comprehension W-1	General Reasoning	109 Women	Naval Recruits	Breech Assembly	.36	(1)
		129 Men			.54	
Bennett Test of Mechanical Comprehension (modified)	General Reasoning	140 ATS	Fitter Trng.	a	.40	(10)
		36 ATS	Instrument Mech. Trng	a	.44	
Minnesota Paper Formboard	Visualization	22 Women	Typewriter	Time to Perform-	.26	
		52 Men	Adjust-Repair	ance Standard	-.12	(5)
MacQuarrie Block Subtest	Visualization	329 Women	Radio Assembly Trng.	Perform. Rating	.32	(4)
Squares	Visualization	36 ATS	Instrument Mech. Trng.	a	.52	(10)
		41 ATS	Driver Mech. Trng.	a	.49	
		30 ATS	Tinsmith Trng.	a	.44	
MacQuarrie Location Subtest	Spatial Relations	329 Women	Radio Assembly Trng.	Perform. Rating	.35	(4)
MacQuarrie Copying Subtest	Flexibility of Closure	329 Women	Radio Assembly Trng.	Perform. Rating	.31	(4)
Experience Check List	Mechancial Exper.	109 Women	Naval Recruits	Breech Assembly	.23	(1)
		129 Men			.29	
Tool Knowledge	Mechanical Exper.	22 Women	Typewriter	Time to Perform-	.00	(5)
		52 Men	Adjust-Repair	ance Standard	-.07	
Hand-Eye Coordination Test	Aiming	22 Women	Typewriter	Time to Perform-	-.07	(5)
		52 Men	Adjust-Repair	ance Standard	-.01	
MacQuarrie Tracing Subtest	Aiming	329 Women	Radio Assembly Trng.	Perform. Ratings	.32	(4)
Navy Mechanical Test	Mechanical Exper.	109 Women	Naval Recruits	Breech Assembly	.39	(1)
	General Reasoning	129 Men			.59	
Navy Arithmetic Test	General Reasoning	109 Women	Naval Recruits	Breech Assembly	.25	(1)
	Number Facility	129 Men			.40	

[a] It is not clear as to the exact assessment used. Principally, there were four criteria: rank ratings, examination mark, ratings of skill, and measure of skill. Same coordination of these assessment was used as the criterion of success in training.

[b] Correlation of test and criterion scores.

knowledge, and flexibility of closure--were generally lower in validity than the three most promising factors. However, the validity coefficients were of sufficient magnitude to indicate that the tests could be useful for the intended objective. Finally, two factors--aiming and mechanical experience--were generally poor predictors in the case of women.

It was noted that, for men, tests having face validity for the mechanical experience factor tended to be good predictors of success in mechanical and electrical jobs. In the case of women, however, the same tests tended to be less predictive of performance in mechanical and electrical jobs. One reason for the difference may be that cultural pressures restrict the extent to which girls can gain mechanical experience of the kind forming the basis for most existing tests of this factor. The relatively low scores consistently obtained by women on existing mechanical experience tests suggest the possibility that more usefully predictive tests might be constructed by using easier items or by basing items on mechanical activities with which women are more likely to be concerned.

In a similar manner, the value of the instruments classified as tests for general reasoning, when used in the selection of women, appeared largely dependent upon whether or not the items comprising these instruments were mechanically oriented. Tests with mechanical content such as the Bennett Mechanical Comprehension Test produced validity coefficients which were adequate for men (.54 to .60) but borderline for women (.33 to .44). Coefficients for three tests composed of mechanically oriented items were lower for women than were coefficients for the non-mechanical reasoning tests (.33 to .44 vs .50 and .57).

The two tests measuring the aiming factor were the only predictors largely concerned with psychomotor elements. The data indicated that the tests were of little value for selecting women for the jobs studied. However, comparable criterion scores on the Breech Block Assembly for men and women (1), and the reported success in prediction obtained through use of Meccano Models in conjunction with paper and pencil mechanical tests (8), suggest that the psychomotor and other factors measured by three-dimensional assembly tests may turn out to be useful for selecting women for mechanical and electrical jobs.

SUMMARY

The literature was reviewed for tests used by the military services and civilian industry to select women for mechanical and electrical jobs. Because of the limitations that were imposed on the review, few relevant studies were found.

The studies reviewed indicated that tests measuring the induction, number facility, and speed of symbol discrimination factors were among the best predictors of success in the

mechanical and electrical occupational areas for women.

Present information tests measuring the mechanical experience factor were not as appropriate for selecting women for mechanical and electrical jobs as they were for men. The value of tests measuring the general reasoning factor appeared to depend upon whether the test was mechanically oriented. The presence of mechanical items appeared to lower the validity coefficients for women.

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