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FACTOR ANALYSIS OF THE ASVAB: CONFIRMING A VERNON-LIKE STRUCTURE

Malcolm James Ree

Thomas R. Carretta

HUMAN RESOURCES DIRECTORATE
Manpower and Personnel Research Division
7909 Lindbergh Drive
Brooks Air Force Base, Texas 78235-5352

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MALCOLM JAMES REE, GS-14, DAF
Scientific Advisor
Aircrew Selection Research Branch

PATRICK C. KYLLONEN
Technical Director
Manpower & Personnel Research Div

GARY D. ZANK, Colonel, USAF
Chief
Manpower and Personnel Research Division

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Thomas R. Carretta
Malcolm James Ree

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Armstrong Laboratory
Human Resources Directorate
Manpower and Personnel Research Division
7909 Lindbergh Drive
Brooks AFB TX 78235-5352

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The Armed Services Vocational Aptitude Battery (ASVAB), has been used in its current item and content form for more than a decade. Its latent structure, although explored in factor analyses, has never been confirmed. Several confirmatory factor analyses were conducted on Form 8a in a nationally representative sample. These included a ***g***-only model, a three-factor hierarchical Vernon-like model, 2 four-factor first-order models, and 2 four-factor hierarchical models. Based on fit indexes, simple structure, and parsimony in parameter estimation, the three-factor hierarchical model was chosen to represent the data. The higher-order factor was psychometric ***g***, and the first-order factors were interpreted as Speed, Verbal/Math, and Technical Knowledge. The latter two factors were similar to Vernon factors of Verbal/Educational and Practical.

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FACTOR ANALYSIS OF THE ASVAB: CONFIRMING A VERNON-LIKE STRUCTURE

MALCOLM JAMES REE AND THOMAS R. CARRETTA
Armstrong Laboratory

The Armed Services Vocational Aptitude Battery (ASVAB) has been used in its current item and content form for more than a decade. Its latent structure, although explored in factor analyses, has never been confirmed. Several confirmatory factor analyses were conducted on Form 8a in a nationally representative sample. These included a *g*-only model, a three-factor hierarchical Vernon-like model, 2 four-factor first-order models, and 2 four-factor hierarchical models. Based on fit indexes, simple structure, and parsimony in parameter estimation, the three-factor hierarchical model was chosen to represent the data. The higher-order factor was psychometric *g*, and the first-order factors were interpreted as Speed, Verbal/Math, and Technical Knowledge. The latter two factors were similar to the Vernon factors of Verbal/Educational and Practical.

The Armed Services Vocational Aptitude Battery (ASVAB; Earles & Ree, 1992) is frequently used for educational counseling and for military enlistment qualification. The tests of the ASVAB are aggregated into composites that reflect meaning for the user. Kass, Mitchell, Grafton, and Wing (1983) identified a four-factor structure for the ASVAB using exploratory methods, but did not confirm the structure through statistical tests. Ree, Mullins, Mathews, and Massey (1982) derived a different four-factor structure but failed to confirm it. Ree and Earles (1991) showed that the ASVAB tests measure mostly psychometric *g*, but did not provide estimates of the factor structure of the tests. This study improves on previous efforts by estimating and confirming the factor structure of the ASVAB, including psychometric *g*.

The opinions expressed are those of the authors and not necessarily those of the Department of the Air Force, Department of Defense, or the U.S. Government. The EQS computer program was used to estimate the structural models. Correspondence or requests for reprints should be sent to the first author at AL/HRMAT, 7909 Lindbergh Drive, Brooks AFB, TX 78235-5352.

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Method

Subjects

The subjects for this study were 11,078 males and females sampled for the national norming of the ASVAB in the fall of 1980 (Maier & Sims, 1986; Ree & Wegner, 1990). In weighted form, the sample represents the population of Americans between the ages of approximately 16 and 23 years.

Measures

ASVAB Form 8a is comprised of 10 tests, including General Science (GS), Arithmetic Reasoning (AR), Word Knowledge (WK), Paragraph Comprehension (PC), Numerical Operations (NO), Coding Speed (CS), Auto and Shop Information (AS), Mathematics Knowledge (MK), Mechanical Comprehension (MC), and Electronics Information (EI). The ASVAB has been validated for training (Earles & Ree, 1992) and job performance (Ree & Earles, 1992, 1993).

Procedures

Six factor models of the ASVAB were proposed and tested using structural equations (Bentler, 1989). These included a *g*-only model based on the work of Ree and Earles (1991), extracting *g* directly from the tests without lower-order common factors; a three-factor hierarchical model based on the work of Vernon (1969); and 2 four-factor models based on Kass et al. (1983) and Ree et al. (1982). These 2 four-factor solutions were also tested with *g* extracted from the lower-order factors to become hierarchical models.

Model 1 had *g* only. Model 2 had three factors and hierarchical *g* depending on all first-order factors (Vernon-like model) with Speed = NO, CS, Verbal/Math = AR, WK, PC, MK, and Technical Knowledge = GS, AS, MC, EI. Model 3 had four factors (Kass et al., 1983) with Verbal = GS, AR, WK, PC, EI, Quantitative = GS, AR, NO, MK, MC, Speed = AR, PC, NO, CS, MK, and Technical Knowledge = GS, AR, WK, PC, AS, MC, EI. Model 4 was Model 3 with hierarchical *g* dependent on all first-order factors. Model 5 was four factors (Ree et al., 1982) with Verbal/Technical Knowledge = GS, WK, PC, EI, Technical Knowledge = AS, MC, EI, Mathematics = AR, MK, MC, and Speed = NO, CS. Model 6 was Model 5 with hierarchical *g* dependent on all first-order factors.

The models were specified by allowing tests to load on some factors and not on others. Factor loadings were free to be estimated for some variables and fixed at zero for others. All the hierarchical models were residualized (Schmid & Leiman, 1957) so that the effect of the higher-order factor was removed from the lower-order factors. For example, the lower-order factors contained none of the hierarchical *g* variance.

The Bentler-Bonnet Comparative Fit Index (CFI; Bentler, 1989) was used to find the best-fitting model because it provided an accurate estimate of fit with low sampling variance. This index is scaled between 0 and 1 with higher values indicating better fit. The model with the highest value fits the data best, although a high fit index cannot be interpreted as indicating that the model is the only one that would give that magnitude of fit. Additionally, interpretability and approximation of simple structure were considered in selecting the most appropriate model.

Results and Discussion

None of the models showed a poor fit to the data (CFI ranged from .991 to .999). The *g*-only model displayed the poorest fit (CFI = .991). The three-factor Vernon-like hierarchical *g* model showed a CFI of .998 with first-order Speed, Verbal/Math, and Technical Knowledge factors. A true Vernon model would have only two factors directly below *g* that would be expected to be Verbal/Educational and Practical. Verbal/Educational and Practical are similar to our Verbal/Math and Technical Knowledge factors.

The Kass et al. (1983) four-factor model had a CFI of .995, but showed poor simple structure with most tests loading on multiple factors and was almost uninterpretable. The Ree et al. (1982) four-factor model did not fit the data as well and produced a CFI of .992, but was more interpretable. The factors approached simple structure and three of the four were interpretable as Technical Knowledge, Mathematics, and Speed. The fourth factor was a mix of Technical Knowledge and Verbal. The Kass et al. (1983) and Ree et al. (1982) models with hierarchical *g* showed CFIs of .999 and .998, respectively. Although good fits to the data, these models suffered from the same problems of interpretability as their first-order counterparts. On the basis of fit, interpretability, and simple structure, the three-factor hierarchical *g* model was chosen as most appropriate to represent the structure of the ASVAB. Although the CFI of .991 for the *g*-only model was not very different than the CFI of .998 of the Vernon-like model, the latter was deemed appropriate because it is consistent with past validity research (Earles & Ree, 1992; Ree & Earles, 1992, 1993), showing small but significant increments for the non-*g* variance in ASVAB. Table 1 presents the factor loadings for both the hierarchical and first-order factors for the three-factor model.

Residualization of the factors removed the effect of *g* from the lower-order factors. The amount of factor variance accounted for by *g* was large, 64%. The amount of variance accounted for by specific or lower-order factors was low, 16%; 20% was due to uniqueness and error.

A similar set of analyses should be performed for population groups such as males and females, and racial/ethnic groups as was done by Kass et al.

Table 1
Factor Loadings of the Three-Factor Hierarchical Solution

	Loadings[a]			
Test	*g*	Speed	Verbal/Math	Technical Knowledge
General Science	.869			.218
Arithmetic Reasoning	.888		.306	
Word Knowledge	.938		–.255	
Paragraph Comprehension	.853		–.112	
Numerical Operations	.722	.320		
Coding Speed	.655	.723		
Auto and Shop Information	.657			.592
Mathematics Knowledge	.838		.274	
Mechanical Comprehension	.738			.454
Electronics Information	.775			.414
Variance percentage	63.8	6.2	2.4	7.7

a. These loadings have been residualized so that the effect of the higher-order factor, *g*, has been removed from the lower-order factors. Variance percentage is the percentage of total variance for which each factor accounts. Approximately 20% of the variance was due to uniqueness and error.

(1983). Such analyses would disclose whether the tests measured the same factors for all groups and would facilitate equal treatment by informing developers about test content as reflected by the factors.

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