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# GROUP DIFFERENCES IN THE ROLE OF *g* AND PRIOR JOB KNOWLEDGE IN THE ACQUISITION OF SUBSEQUENT JOB KNOWLEDGE[1][2]

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**Summary** --- The role of ability and prior job knowledge on the acquisition of subsequent job knowledge was examined for 41,976 participants in technical training. Comparisons were made for samples of men and women and for Whites, Blacks, and Hispanics. Ability and prior job knowledge were measured prior to entering job training and subsequent job knowledge was measured at the completion of job training. The structural equation model that was used had been statistically confirmed and had shown a role for both ability and prior job knowledge. In all groups, the relative causal impact of ability was far greater than that of prior job knowledge. It should be noted, however, that the relative causal impact of ability and prior job knowledge varied by group, being greater for men and Blacks. Contrary to expectations, prior job knowledge had virtually no causal role regarding the acquisition of subsequent job knowledge for women. The $R^2$ for predicting subsequent job knowledge was about equal for men and women, but less for Blacks than for Whites or Hispanics.

*Key Words:* general cognitive ability, job knowledge, causal models, sex and ethnic group differences, knowledge acquisition

Several principles must be considered when studying the measurement of ability in sex or ethnic groups. For instance, the same factors should be measured for all groups and the relationships among the factors should be the same for all groups. McArdle (1996) contends that factorial invariance (i.e., equality of factor loadings) should be established before other group comparisons (e.g., mean differences) are considered. Further, McArdle contends that a failure to observe factorial invariance may indicate that the psychological constructs being measured are qualitatively different for the groups being compared. This, in turn, would limit the interpretability of other comparisons.

Previous research examining invariance in structural models across groups has focused for the most part on factorial models of ability (Carretta & Ree, 1995, 1997b; DeFries *et al*, 1974;

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Humphreys & Taber, 1973; Michael, 1949; Ree & Carretta, 1995). These studies have demonstrated a remarkable degree of factoral similarity in the structure of ability across diverse groups.

Only one study was found that used structural models to examine invariance in causal models of ability, job knowledge, and job performance across groups. Carretta and Ree (1997a) used structural models to examine sex differences in the role of ability and prior job knowledge on the acquisition of subsequent job knowledge and work sample performance in a sample of 3,369 male and 59 female U. S. Air Force pilot trainees. Carretta and Ree viewed their results as tentative because of the small sample of female pilot trainees in their sample. Their model showed a direct influence of general cognitive ability (*g*) on the acquisition of job knowledge and an indirect influence on work sample performance. The direct and indirect influence of cognitive ability on flying skills was stronger for females than for males. Additionally, the path between prior job knowledge and work sample performance was stronger for females than for males.

The purpose of this study was to examine the role of ability and prior job knowledge in the acquisition of subsequent job knowledge for men and women and for three ethnic groups. The model used specifies positive causal paths for both *g* and prior job knowledge in the acquisition of subsequent job knowledge and was based on the findings of Hunter (1983, 1986), Dye, Reck, and McDaniel (1993), Ree, Carretta, and Teachout (1995), and Ree, Carretta, and Doub (1998/1999).

The model being tested in this study was statistically confirmed by Ree et al. (1998/1999). Ree et al.'s results showed a role for both ability and prior job knowledge for 42,399 U. S Air Force enlisted personnel in two broad job families (electronic and mechanical). Similar results were observed when analyses considered electronics jobs only, mechanical jobs only, and for all jobs. For the model that included all jobs (Figure 1), the $R^2$ for predicting subsequent job knowledge ($JK_S$) was .80 and the causal impact of ability (*g*) was about three times that of prior job knowledge ($JK_P$). The current study extends these findings by evaluating the suitability of the Ree et al. (1998/1999) model for men and women and for Whites, Blacks, and Hispanics.

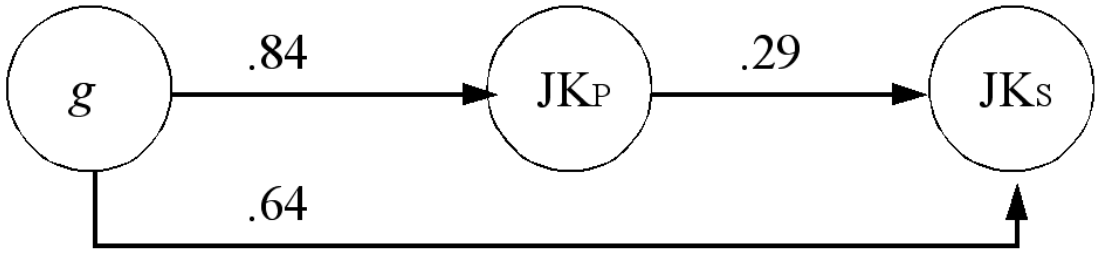


Figure 1. Ree, Carretta, and Doub (1998/1999) structural model of the role of *g* and prior job knowledge ($JK_P$) on the acquisition of subsequent job knowledge ($JK_S$).

# METHOD

## *Participant*

The participants were 41,976 U. S. Air Force enlisted personnel who attended and completed a technical training course for one of several job specialties in either the electronics or mechanical career field. They were between about 17 and 23 years old, mostly male (90.8%) and White (87.1%), with a high school or better education (99%). All had tested for enlistment qualification between 1984 and 1988. They had been selected for formal technical training on the basis of both *g* and prior job knowledge.

The samples consisted of 38,134 males, 3,842 females, 35, 635 Whites, 4,205 Blacks, and 1,080 Hispanics. For most training courses, applicants must qualify on only one of the technical composites (either electronics or mechanical). A few courses require applicants to qualify on both electronics and mechanical composites, and some allow qualification on either the electronics or mechanical knowledge composites.

## *Measures*

The ASVAB is a multiple aptitude battery composed of 10 tests. It is based on a detailed written taxonomy of test and item specifications that defines the content and psychometric characteristics of each test. The ASVAB has been validated for training (Earles & Ree, 1992) and job performance (Ree, Earles, & Teachout, 1994).

The ASVAB has a hierarchical factor structure that includes *g* as a higher-order factor and three lower-order factors of verbal/quantitative, speed, and technical job knowledge (Ree & Carretta, 1994). The verbal and quantitative tests are Word Knowledge (WK), Paragraph Comprehension (PC), Arithmetic Reasoning (AR), and Mathematics Knowledge (MK). Numerical Operations (NO) and Coding Speed (CS) are the two speed tests. The technical knowledge tests are Electronics Information (EI), Mechanical Comprehension (MC), Auto and Shop Information (A/S), and General Science (GS). Brief descriptions of the tests are provided below. More detailed descriptions and example items of the tests are available in the *ASVAB Information Pamphlet* (DOD, 1984) which is given to all applicants prior to testing.

*g and prior job knowledge*. Measures of general cognitive ability (*g*) and prior job knowledge, ($JK_P$) were extracted from the Armed Services Vocational Aptitude Battery (ASVAB; Earles & Ree, 1992). As in Ree et al. (1998/1999), *g* was extracted as a latent factor from the two verbal and two quantitative tests (WK, PC, AR, and MK). WK measures knowledge of synonyms and PC measures short-paragraph reading comprehension. AR assesses the ability to solve arithmetic word problems and MK measures problem solving using high school mathematics.

Job knowledge was extracted as a latent factor from the EI, MC, and A/S tests. The GS, NO, and CS tests were not used because they do not measure job knowledge that is specific to any job family. The EI test measures knowledge about elementary electrical principles and electronics. MC measures knowledge of mechanical principals and tools. The A/S test assesses knowledge about automotive systems and shop practices.

*Criterion.* The criterion, subsequent job knowledge acquired during training ($JK_S$), was an observed variable. It was based on final grades on job knowledge tests taken during technical training. These grades were the average percent correct on several (at least four, but sometimes more) multiple choice tests and ranged from 70 to 99. Each technical course scaled the grades independently and no common metric exists for the set of grades. Those assigning the training grades did not estimate their reliability nor were the data available to directly estimate reliability.

Course length varies by job specialty. Typically, these training courses last between two and eight months. Attrition rates for these courses are quite low, averaging about six percent. Attrition from military courses has several characteristics. Some who fail are separated from service. Others are transferred to different training courses or to jobs that do not require formal training.

*Job Families*

All enlisted Air Force jobs are categorized into one of four major job families (mechanical, administrative, general, and electronics). These job families were determined by clustering regression equations of the ASVAB tests (Alley, Treat, & Black, 1988) and policy decisions by senior executives. As previously noted, only electronics and mechanical jobs were considered in this study because there are no job-specific technical knowledge tests on the ASVAB for administrative or general jobs.

Final technical training grades were used as criteria in the regressions. The Air Force uses both general ability (i.e., Armed Forces Qualification Test or AFQT) and specific composites (Mechanical, Administrative, General, and Electronics) of the ASVAB for placing applicants into specific jobs.

All applicants for enlistment are screened on *g* via the composite of two verbal and two quantitative tests (i.e., AFQT). For jobs in the electronics family, applicants must also achieve minimum scores on a composite made up of Electronics = AR + MK + EI + GS. EI provides a measure of prior job knowledge for electronics jobs. Applicants for mechanical jobs must qualify on a composite made up of Mechanical = MC + GS + 2A/S. MC and A/S are measures of prior job knowledge for mechanical jobs. Even though GS is a measure of technical knowledge, it is not a content-relevant measure of job knowledge for these electronics or mechanical occupations.

The assignment of jobs to job families and minimum test score requirements are controlled by official regulations. Electronics jobs include the broad areas of aircraft electronics, communications-electronics repair and maintenance, missile electronics maintenance, precision measurement equipment repair and calibration, and others. Mechanical jobs include the broad areas of missile, vehicle, and airframe maintenance, munitions and weapons, fuels, structural/pavements, and others.

*Analyses*

Data were combined across the electronics and mechanical job families as Ree et al. (1998/1999) reported that the model combining all jobs did not differ from models based on specific job families. It was also felt that this general model was superior to the job-family-

specific models (electronics or mechanical separately) as the measure of prior job knowledge ($JK_P$) was more reliable because it was based on three tests (EI, MC, and A/S) rather than one (electronics = EI) or two (mechanical = MC and A/S).

Participants represented a range restricted sample because they had been selected, at least in part, on the basis of their ASVAB scores. To correct for the estimation bias introduced by range restriction, each group-specific correlation matrix of test scores and criterion was corrected. The multivariate procedure of Lawley (1943) was used within each sex and ethnic group to correct the mean, variance, and correlation estimates of the tests and criterion back to that particular group's normative sample (Bock & Moore, 1984; Ree & Wegner, 1990).

Structural equation analyses based on the range-restricted-corrected correlations were estimated with the LISREL 8 program (Jöreskog & Sörbom, 1993). All measurement models included a mixture of latent and observed variables.

General cognitive ability (*g*) was a latent variable derived from the verbal (PC, WK) and quantitative (AR, MK) tests. An Eigenanalysis of the four cognitive tests was done separately for males, females, Whites, Blacks, and Hispanics to determine whether g was being measured in the same way for each group. The magnitude of the Eigenvalues was examined. A relatively large first Eigenvalue would be consistent with a general factor.

Prior job knowledge ($JK_P$) was a latent variable derived from the Electronics Information (EI), Mechanical Comprehension (MC), and Auto and Shop Information tests (A/S). The criterion, subsequent job knowledge ($JK_S$), was an observed variable. The reliability (.80) of the observed criterion was taken from Pearlman, Schmidt, and Hunter (1980). This value was used in the structural equation analysis.

The models tested were designed to compare the majority group (males or Whites) with the minority group (females, Blacks, or Hispanics). The base model had all restrictions in place, thus imposing the same model for the two groups being compared (males vs. females, Whites vs. Blacks, or Whites vs. Hispanics). Subsequent models relaxed restrictions on the means, variances, and causal links in a prescribed order. If the release of a constraint results in a significantly better fit (e.g., reduced chi-square), this is support for differing models for the groups being compared (i.e., lack of invariance), and thus, evidence for potential bias.

Once the final model was determined for each pair of groups (males vs. females, Whites vs. Blacks, and Whites vs. Hispanics), the direct and indirect influence for each antecedent variable was calculated as was the $R^2$ for the dependent variable of subsequent job knowledge. Goodness-of-fit for the structural models was measured by the chi-square value, Comparative Fit Index (CFI), and Root Mean Square Error of Approximation (RMSEA). The CFI is an extension of the Tucker-Lewis (TLI) fit index, but is less sensitive to sample size than the TLI. CFI values above .90 are considered as good fit. Model chi-square and RMSEA provide measures of error per parameter estimated. The lower the chi-square and RMSEA the better.

## RESULTS

Tables 1a and 1b show the means and standard deviations for the seven ASVAB tests and criterion by group. Prior to correction for range restriction, females had higher means than males on all four verbal and quantitative tests that contribute to the measure of *g* (average *d* value of -.299). Males, however, scored higher on the three technical knowledge tests (average *d* value of .942). After correction for range restriction to the normative samples, the difference on the verbal and quantitative tests almost vanished (average *d* of .055), but males still scored higher than females on the technical knowledge tests (average *d* of .868).

Whites scored higher than Blacks and Hispanics on all tests, both prior to and after correction for range restriction. Prior to correction, Whites averaged .373 *d* higher than Blacks and .288 *d* higher than Hispanics on the verbal and quantitative tests. They also averaged .806 *d* and .433 *d* higher on the technical knowledge tests. These mean differences increased after correction for range restriction (1.117 *d* and 1.104 *d* for the verbal and quantitative tests; 1.165 *d* and .751 *d* for the technical knowledge tests).

Table 1. Means and Standard Deviations of the Scores by Group

a. Males and Females

| | Observed | | | | Corrected for Range Restriction | | | |
|---|---|---|---|---|---|---|---|---|
| | Males | | Females | | Males | | Females | |
| Score | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| AR | 54.78 | 6.32 | 55.59 | 6.04 | 51.33 | 10.22 | 48.55 | 9.58 |
| WK | 54.22 | 4.77 | 56.28 | 4.11 | 49.92 | 10.23 | 50.03 | 9.68 |
| PC | 54.98 | 5.11 | 57.04 | 3.96 | 49.12 | 10.41 | 50.97 | 9.54 |
| A/S | 58.32 | 6.50 | 49.38 | 5.82 | 55.18 | 9.81 | 44.60 | 6.84 |
| MK | 54.80 | 7.53 | 56.45 | 7.02 | 50.70 | 10.32 | 49.28 | 9.57 |
| MC | 58.52 | 6.45 | 54.20 | 6.25 | 53.78 | 10.22 | 46.10 | 8.19 |
| EI | 56.77 | 7.00 | 51.45 | 6.40 | 53.55 | 10.02 | 46.28 | 8.53 |
| Criterion | 87.45 | 6.24 | 86.20 | 6.15 | 84.30 | 8.50 | 81.12 | 8.29 |

b. Whites, Blacks, and Hispanics

| | Observed | | | | | | Corrected for Range Restriction | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Whites | | Blacks | | Hispanics | | Whites | | Blacks | | Hispanics | |
| Score | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| AR | 55.23 | 6.23 | 52.01 | 6.20 | 54.05 | 6.04 | 51.87 | 9.53 | 41.45 | 7.31 | 43.84 | 8.98 |
| WK | 54.75 | 4.59 | 52.71 | 4.89 | 51.65 | 5.45 | 52.14 | 8.38 | 40.25 | 10.76 | 43.15 | 11.07 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PC | 55.45 | 4.92 | 53.32 | 5.50 | 54.24 | 5.25 | 51.94 | 8.78 | 41.75 | 10.80 | 43.53 | 11.50 |
| A/S | 58.44 | 6.53 | 51.27 | 6.63 | 54.60 | 6.70 | 51.92 | 9.35 | 41.07 | 7.41 | 47.12 | 10.08 |
| MK | 55.00 | 7.56 | 54.19 | 6.97 | 54.65 | 7.23 | 51.54 | 9.78 | 43.41 | 7.71 | 44.51 | 9.19 |
| MC | 58.78 | 6.33 | 53.44 | 6.45 | 56.27 | 6.28 | 51.93 | 9.52 | 41.28 | 7.15 | 44.02 | 9.55 |
| EI | 56.72 | 7.04 | 53.33 | 7.00 | 54.30 | 7.02 | 51.98 | 9.17 | 41.10 | 8.33 | 43.30 | 10.18 |
| Criterion | 87.66 | 6.19 | 85.05 | 6.05 | 86.19 | 6.36 | 84.32 | 7.81 | 77.97 | 6.98 | 78.75 | 8.40 |

Tables 2a through 2e show the correlations of the tests and criterion by group. Note that the corrected intercorrelations differ across sex and ethnic groups as each group was corrected back to its normative sample. Corrected correlations were used in all analyses that follow.

Eigenanalyses of the four tests used to measure *g* were done separately for each group. In each case, one large factor was disclosed that accounted for most of the variance (males, 80.5%; females, 78.4%; Whites, 75.9%; Blacks, 75.2%; Hispanics, 78.8%). Minor verbal and quantitative content factors accounted for the remaining variance. Others have defined this common variance as *g* (Jensen, 1980) and have used scores from these tests as measures of *g* (Herrnstein & Murray, 1994).

Table 2. Correlations of the Scores by Group

a. Males

| Score | AR | WK | PC | A/S | MK | MC | EI | Criterion |
|---|---|---|---|---|---|---|---|---|
| AR | 1.0000 | 0.3165 | 0.3297 | 0.1516 | 0.6464 | 0.4431 | 0.2980 | 0.3863 |
| WK | 0.7231 | 1.0000 | 0.4827 | 0.2106 | 0.3411 | 0.3502 | 0.4165 | 0.2937 |
| PC | | 0.7172 | 0.8159 | 1.0000 | 0.1476 | 0.3138 | 0.2775 | 0.3101 0.2813 |
| A/S | 0.5558 | 0.6525 | 0.5693 | 1.0000 | -0.0025 | 0.3691 | 0.4285 | 0.2344 |
| MK | 0.8313 | 0.6830 | 0.6699 | 0.4327 | 1.0000 | 0.3894 | 0.3017 | 0.3803 |
| MC | 0.7028 | 0.6824 | 0.6382 | 0.7468 | 0.6164 | 1.0000 | 0.4280 | 0.3285 |
| EI | 0.6857 | 0.7760 | 0.6899 | 0.7478 | 0.6196 | 0.7666 | 1.0000 | 0.3422 |
| Criterion | 0.6963 | 0.6751 | 0.6500 | 0.5892 | 0.6609 | 0.6460 | 0.6713 | 1.0000 |

b. Females

| Score | AR | WK | PC | A/S | MK | MC | EI | Criterion |
|---|---|---|---|---|---|---|---|---|
| AR | 1.0000 | 0.2600 | 0.2700 | 0.0097 | 0.6270 | 0.2959 | 0.2303 | 0.3657 |
| WK | 0.7070 | 1.0000 | 0.4399 | 0.1602 | 0.2354 | 0.2086 | 0.3218 | 0.2574 |
| PC | 0.6671 | 0.7937 | 1.0000 | 0.0843 | 0.2501 | 0.1594 | 0.2454 | 0.2369 |
| A/S | 0.5479 | 0.6052 | 0.5537 | 1.0000 | -0.1336 | 0.2670 | 0.2576 | 0.0492 |
| MK | 0.8216 | 0.6590 | 0.6214 | 0.4783 | 1.0000 | 0.2272 | 0.2248 | 0.3725 |
| MC | 0.6767 | 0.5985 | 0.5602 | 0.5816 | 0.6329 | 1.0000 | 0.2656 | 0.1363 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| EI | 0.6257 | 0.6880 | 0.6078 | 0.6247 | 0.5800 | 0.6054 | 1.0000 | 0.2358 |
| Criterion | 0.6774 | 0.6671 | 0.6263 | 0.4962 | 0.6580 | 0.5282 | 0.5788 | 1.0000 |

c. Whites

| Score | AR | WK | PC | A/S | MK | MC | EI | Criterion |
|---|---|---|---|---|---|---|---|---|
| AR | 1.0000 | 0.3284 | 0.3359 | 0.0893 | 0.6583 | 0.4127 | 0.2772 | 0.3736 |
| WK | 0.6617 | 1.0000 | 0.4876 | 0.0998 | 0.3666 | 0.2937 | 0.3711 | 0.2855 |
| PC | 0.6224 | 0.7522 | 1.0000 | 0.0545 | 0.3365 | 0.2276 | 0.2686 | 0.2703 |
| A/S | 0.4333 | 0.3964 | 0.2766 | 1.0000 | -0.0281 | 0.3645 | 0.4568 | 0.2159 |
| MK | 0.8147 | 0.6306 | 0.5882 | 0.3099 | 1.0000 | 0.3785 | 0.2889 | 0.3777 |
| MC | 0.6352 | 0.5054 | 0.4245 | 0.6995 | 0.5470 | 1.0000 | 0.4391 | 0.3166 |
| EI | 0.5939 | 0.6053 | 0.4684 | 0.7002 | 0.5215 | 0.7023 | 1.0000 | 0.3400 |
| Criterion | 0.6410 | 0.5790 | 0.5283 | 0.4825 | 0.6078 | 0.5675 | 0.5867 | 1.0000 |

d. Blacks

| Score | AR | WK | PC | A/S | MK | MC | EI | Criterion |
|---|---|---|---|---|---|---|---|---|
| AR | 1.0000 | 0.1447 | 0.1814 | -0.0490 | 0.5759 | 0.2550 | 0.1402 | 0.3203 |
| WK | 0.6218 | 1.0000 | 0.4079 | 0.0485 | 0.2246 | 0.2011 | 0.2851 | 0.1667 |
| PC | 0.6012 | 0.7940 | 1.0000 | -0.0204 | 0.1909 | 0.1236 | 0.1842 | 0.1614 |
| A/S | 0.4815 | 0.5240 | 0.4425 | 1.0000 | -0.1689 | 0.2510 | 0.3070 | 0.0521 |
| MK | 0.7243 | 0.6460 | 0.6280 | 0.4317 | 1.0000 | 0.2299 | 0.1499 | 0.3377 |
| MC | 0.5046 | 0.5197 | 0.4625 | 0.5968 | 0.4874 | 1.0000 | 0.2948 | 0.1458 |
| EI | 0.5391 | 0.6339 | 0.5533 | 0.6272 | 0.5105 | 0.6048 | 1.0000 | 0.2005 |
| Criterion | 0.5294 | 0.5138 | 0.4924 | 0.3953 | 0.5391 | 0.3796 | 0.4584 | 1.0000 |

e. Hispanics

| Score | AR | WK | PC | A/S | MK | MC | EI | Criterion |
|---|---|---|---|---|---|---|---|---|
| AR | 1.0000 | 0.1877 | 0.2236 | 0.0109 | 0.6285 | 0.3244 | 0.2185 | 0.3556 |
| WK | 0.7109 | 1.0000 | 0.4481 | 0.1872 | 0.1756 | 0.2707 | 0.2673 | 0.1905 |
| PC | 0.6754 | 0.7981 | 1.0000 | 0.0504 | 0.2097 | 0.1857 | 0.2213 | 0.2103 |
| A/S | 0.5944 | 0.6433 | 0.5691 | 1.0000 | -0.0989 | 0.2776 | 0.3237 | 0.1490 |
| MK | 0.8046 | 0.6608 | 0.6489 | 0.5201 | 1.0000 | 0.2972 | 0.2655 | 0.3839 |
| MC | 0.6908 | 0.6368 | 0.5918 | 0.7341 | 0.6370 | 1.0000 | 0.3152 | 0.2174 |
| EI | 0.6958 | 0.7217 | 0.6611 | 0.7497 | 0.6506 | 0.7430 | 1.0000 | 0.2976 |
| Criterion | 0.6660 | 0.6257 | 0.6154 | 0.5792 | 0.6550 | 0.5859 | 0.6411 | 1.0000 |

Note. Correlations above the diagonal are observed. Those below the diagonal were corrected for range restriction (Lawley, 1943).

Table 3 provides the correlations among the latent variables for each group as estimated in the measurement model by LISREL 8.

The models fit the data well. Table 4 summarizes the sequential model testing for the models comparing males and females, Whites and Blacks, and Whites and Hispanics. Consistent with the

mean and standard deviation comparisons reported in Table 1, release of the constraints involving means and variances led to substantial improvement in model fit. Relaxing constraints

Table 3. Correlations among the latent variables

| Males | | | Females | | |
|---|---|---|---|---|---|
| *g* | $JK_P$ | $JK_S$ | *g* | $JK_P$ | $JK_S$ |
| 1.000 | | | 1.000 | | |
| 0.903 | 1.000 | | 0.904 | 1.000 | |
| 0.778 | 0.758 | 1.000 | 0.772 | 0.694 | 1.000 |

| Whites | | | Blacks | | |
|---|---|---|---|---|---|
| *g* | $JK_P$ | $JK_S$ | *g* | $JK_P$ | $JK_S$ |
| 1.000 | | | 1.000 | | |
| 0.806 | 1.000 | | 0.808 | 1.000 | |
| 0.725 | 0.677 | 1.000 | 0.625 | 0.546 | 1.000 |

| Hispanics | | |
|---|---|---|
| *g* | $JK_P$ | $JK_S$ |
| 1.000 | | |
| 0.874 | 1.000 | |
| 0.749 | 0.709 | 1.000 |

Note. Correlations were estimated by the structural equation program. *g* is general cognitive ability. $JK_P$ is prior job knowledge and $JK_S$ is subsequent job knowledge acquired during training.

involving path values also helped improve fit (as measured by reduction in chi-square) but by a lesser amount.

The final group-specific causal models with all constraints released are shown in Figure 2a through 2c. The impact of *g* on $JK_P$ was nearly identical for men and women (.904 vs. .903 for $g \rightarrow JK_P$), but the values for the other two paths differed. The $g \rightarrow JK_S$ path was much stronger for women (.793) than for men (.504), whereas the $JK_P \rightarrow JK_S$ path was stronger for men (.303) than for women (-.024). However, the total of the direct and indirect effects of *g* on $JK_S$ was about the same for both sexes (.778 for men and .772 for women). The $R^2$ values for $JK_S$ were .622 for men and .596 for women.

The White-Black and White-Hispanic comparisons produced similar, but not identical causal models for those groups. The impact of *g* on $JK_P$ was nearly identical for Whites (.806) and

Blacks (.808), but slightly greater for Hispanics (.874). The $g \rightarrow JK_S$ values were .512, .529, and .548 respectively, for Whites, Blacks, and Hispanics and the $JK_P \rightarrow JK_S$ values were .264, .118, and .229. The total effect of *g* on $JK_S$ was greater for Whites (.725) and Hispanics (.749) than for Blacks (.625). Also, the $R^2$ values for $JK_S$ were greater for Whites (.550) and Hispanics (.573) than for Blacks (.395).

Table 4. Summary of model testing results by group comparison

Males vs. Females

| strictions Relaxed | Chi-Square | df | df Difference | Diff. | RMSEA | CFI |
|---|---|---|---|---|---|---|
| None: everything fixed | 20,489 | 60 | ---- | ---- | 0.0901 | 0.948 |
| Means for $JK_P$ free | 13,379 | 57 | 3 | 7,110 | 0.0746 | 0.957 |
| Means for $JK_S$ free | 12,552 | 56 | 1 | 827 | 0.0729 | 0.959 |
| Mean for *g* free (same as all means free) | 11,354 | 52 | 4 | 1,196 | 0.0720 | 0.962 |
| Variances of latent variables free | 11,009 | 49 | 3 | 345 | 0.0730 | 0.963 |
| Variances of observed variables free | 10,703 | 42 | 7 | 306 | 0.0778 | 0.964 |
| Path from $JK_P \rightarrow$ observed variables free | 10,648 | 40 | 2 | 55 | 0.0795 | 0.964 |
| Path from $g \rightarrow$ observed variables free | 10,584 | 37 | 3 | 64 | 0.0824 | 0.965 |
| Path from $g \rightarrow JK_P$ free | 10,212 | 36 | 1 | 372 | 0.0821 | 0.966 |
| . Path from $g \rightarrow JK_S$ free | 10,206 | 35 | 1 | 6 | 0.0832 | 0.966 |
| . Path from $JK_P \rightarrow JK_S$ free | 10,121 | 34 | 9 | 85 | 0.0841 | 0.966 |

Whites vs. Blacks

| strictions Relaxed | Chi-Square | df | df Difference | Diff. | RMSEA | CFI |
|---|---|---|---|---|---|---|
| None: everything fixed | 21,954 | 60 | ---- | ---- | 0.0957 | 0.960 |
| Means for $JK_P$ free | 20,417 | 57 | 3 | 1,537 | 0.0947 | 0.956 |
| Means for $JK_S$ free | 20,408 | 56 | 1 | 9 | 0.0955 | 0.956 |
| Mean for *g* free (same as all means free) | 13,410 | 52 | 4 | 6,998 | 0.0803 | 0.940 |
| Variances of latent variables free | 12,830 | 49 | 3 | 580 | 0.0809 | 0.943 |
| Variances of observed variables free | 11,991 | 42 | 7 | 839 | 0.0845 | 0.946 |
| Path from $JK_P \rightarrow$ observed variables free | 11,816 | 40 | 2 | 175 | 0.0860 | 0.947 |
| Path from $g \rightarrow$ observed variables free | 10,205 | 37 | 3 | 1,611 | 0.0831 | 0.954 |
| Path from $g \rightarrow JK_P$ free | 10,141 | 36 | 1 | 64 | 0.0839 | 0.955 |
| . Path from $g \rightarrow JK_S$ free | 10,130 | 35 | 1 | 11 | 0.0851 | 0.955 |
| . Path from $JK_P \rightarrow JK_S$ free | 10,082 | 34 | 1 | 48 | 0.0861 | 0.955 |

Whites vs. Hispanics

| strictions Relaxed | Chi-Square | df | df Difference | Diff | RMSEA | CFI |
|---|---|---|---|---|---|---|
| None: everything fixed | 11,975 | 60 | ---- | ---- | 0.0735 | 0.971 |
| Means for $JK_P$ free | 11,661 | 57 | 3 | 314 | 0.0745 | 0.969 |
| Means for $JK_S$ free | 11,659 | 56 | 1 | 2 | 0.0751 | 0.969 |
| Mean for *g* free (same as all means free) | 10,428 | 52 | 4 | 1,231 | 0.0737 | 0.951 |
| Variances of latent variables free | 10,364 | 49 | 3 | 64 | 0.0757 | 0.951 |
| Variances of observed variables free | 10,222 | 42 | 7 | 142 | 0.0813 | 0.952 |
| Path from $JK_P \rightarrow$ observed variables free | 10,189 | 40 | 2 | 33 | 0.0831 | 0.952 |
| Path from $g \rightarrow$ observed variables free | 9,986 | 37 | 3 | 203 | 0.0856 | 0.953 |
| Path from $g \rightarrow JK_P$ free | 9,885 | 36 | 1 | 101 | 0.0863 | 0.953 |
| . Path from $g \rightarrow JK_S$ free | 9,880 | 35 | 1 | 5 | 0.0875 | 0.953 |
| . Path from $JK_P \rightarrow JK_S$ free | 9,870 | 34 | 1 | 10 | 0.0888 | 0.953 |

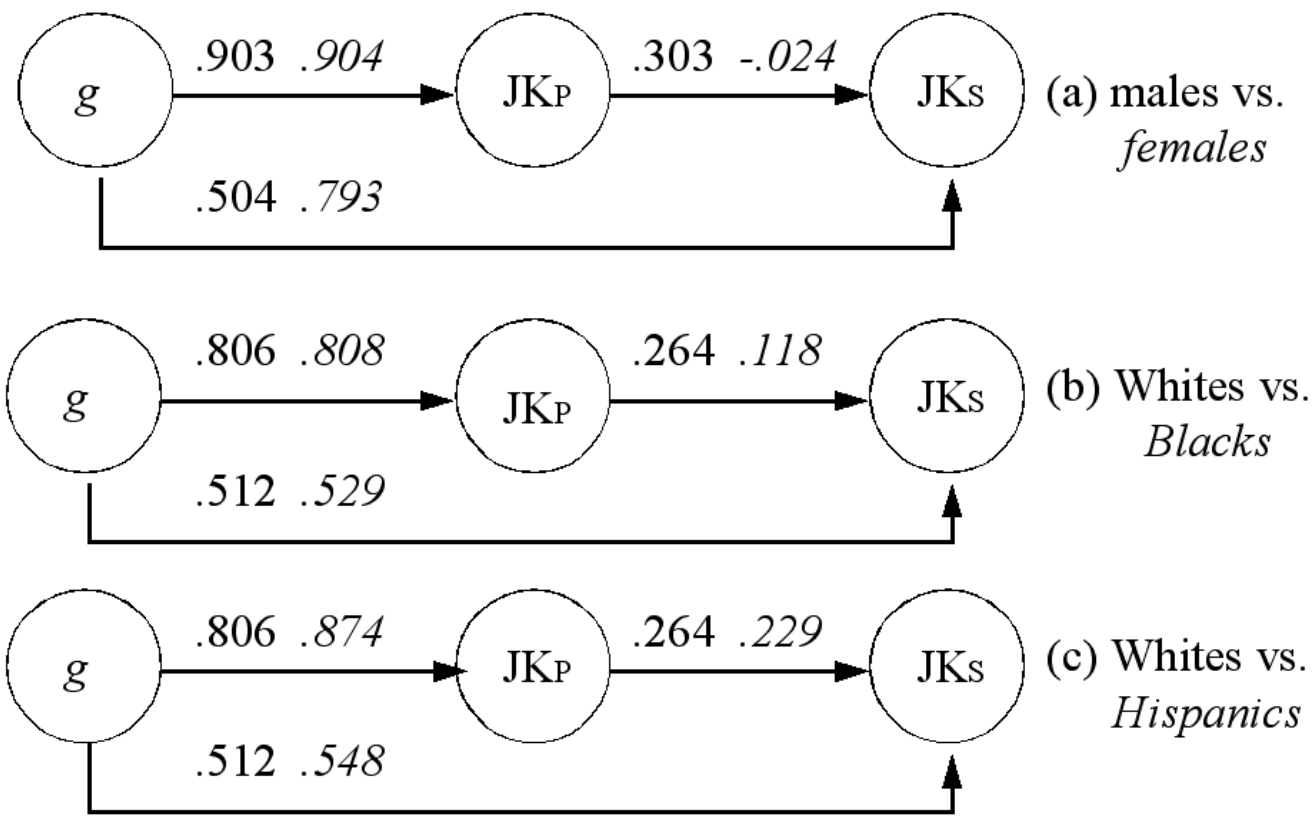


Figure 2. Path models for group comparisons.
Note. Figure 2a, 2b, and 2c compare males and females, Whites and Blacks, and Whites and Hispanics, respectively. The path coefficients for females, Blacks, and Hispanics are in italics.

## DISCUSSION

Although the joint models that fixed parameter estimates to be equal between pairs of groups fit the data well, the sequential model tests comparing joint models for males and females, Whites and Blacks, and Whites and Hispanics indicated that model fit could be improved substantially by allowing separate group estimates. Relaxing equality constraints for means and variances was especially helpful in improving model fit.

The effect of *g* on the acquisition of subsequent job knowledge was greater than the effect of prior job knowledge for all groups. However, the relative impact of *g* versus prior job knowledge and the manner in which it exerted its influence (directly vs. indirectly through $JK_P$) varied substantially by group.

For men and women, the total causal influence of *g* on subsequent job knowledge was about equal (.778 vs. .772) as was the amount of variance accounted for in subsequent job knowledge ($R^2$) by the antecedent variables (.622 vs. .596). However, for men the influence of *g* was split between direct and indirect, whereas for women it was entirely direct. This is consistent with a study of the role of ability and prior job knowledge on the acquisition of additional job knowledge and work sample performance for male and female pilot trainees (Carretta & Ree, 1997a). Carretta and Ree found that *g* exerted a greater causal influence for women than for men, but that the variance accounted for in the final training performance criteria was about equal for both sexes.

Perhaps the most surprising result in the current study was the near zero $JK_P \rightarrow JK_S$ causal path for women. This implies no role for prior job knowledge in the acquisition of subsequent job knowledge for women.

For the ethnic groups, the total causal influence of *g* on subsequent job knowledge was somewhat greater for Whites and Hispanics than for Blacks. However, the relative effect of *g* versus prior job knowledge on subsequent job knowledge was less for Whites (.725/.264 = 2.75 times) and Hispanics (.749/.229 = 3.27 times) than for Blacks (.625/.118 = 5.29 times). It should also be noted that the amount of variance accounted for in subsequent job knowledge by the antecedent variables was greater for Whites (.550) and Hispanics (.573) than it was for Blacks (.395). The cause for this is unknown, but appears related to the weak causal link from $JK_P \rightarrow JK_S$ for Blacks.

These results suggest that measures of *g* will be better determinants of training performance than measures of prior job knowledge. This appears especially true for women and Blacks, The reason for this finding for women and Blacks is unknown. One possibility is that they are less likely to acquire the type of prior job knowledge measured by the ASVAB tests, than are males, Whites, and Hispanics. Evidence for this interpretation is provided by the large male-female and White-Black mean score differences observed on the technical knowledge tests. As a result of their relatively poor prior technical knowledge, women and Blacks may have to rely more on their general cognitive ability when entering these technical training programs.

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