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# General Mental Ability in the World of Work: Occupational Attainment and Job Performance

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The psychological construct of general mental ability (GMA), introduced by C. Spearman (1904) nearly 100 years ago, has enjoyed a resurgence of interest and attention in recent decades. This article presents the research evidence that GMA predicts both occupational level attained and performance within one's chosen occupation and does so better than any other ability, trait, or disposition and better than job experience. The sizes of these relationships with GMA are also larger than most found in psychological research. Evidence is presented that weighted combinations of specific aptitudes tailored to individual jobs do not predict job performance better than GMA alone, disconfirming specific aptitude theory. A theory of job performance is described that explicates the central role of GMA in the world of work. These findings support Spearman's proposition that GMA is of critical importance in human affairs.

During the 1960s when we were graduate students, we frequently heard predictions from experimental psychologists and experimental social psychologists that in 20 or so years differential psychology would be a dead field, because experimental research would explain all individual differences as effects of past or present (environmental) treatment conditions. Obviously, this has not happened. In fact, in recent years there has been a strong resurgence of interest in the psychology of individual differences (Lubinski, 2000). This resurgence embraces general intelligence (general mental ability, GMA), specific aptitudes and abilities, personality traits, interests, values, and other traits showing important differences between individuals and groups.

This resurgence has been particularly strong in connection with GMA, a construct first postulated and defined nearly 100 years ago by Spearman (1904). A number of developments and findings have contributed to renewed interest in GMA. The accumulated evidence has become very strong that GMA is correlated with a wide variety of life outcomes, ranging from risky health-related behaviors, to criminal offenses, to the ability to use a bus or subway system (Gottfredson, 1997; Lubinski & Humphreys, 1997). In addition, the more highly a given GMA measure loads on the general factor in mental ability (the *g* factor), the larger are these correlations. The relative standing of individuals on GMA has been found to be stable over periods of more than 65 years (Deary, Whalley, Lemmon, Crawford, & Starr, 2000). Findings in behavior genetics, including studies of identical twins reared apart and together (e.g., Bouchard, Lykken, McGue, Segal, & Tellegen, 1990), have shown beyond doubt that GMA has a strong genetic basis (e.g., Bouchard, 1998; McGue & Bouchard, 1998). Heritability has been shown to increase with age and to reach levels of .80 or higher in elderly persons. (The square root of .80 is .89, indicating a correlation of nearly .90 between genes and GMA in elderly persons.) Molecular genetic research has identified specific genes that affect particular traits (e.g., Hamer & Copeland, 1998), and this research effort and its findings have changed the intellectual zeitgeist and affected many basic assumptions. Other factors include Carroll's (1993) book on the factor structure of human abilities, Jensen's two major books on GMA (Jensen, 1980, 1998), and Herrnstein and Murray's (1994) *Bell Curve*, the only social science book ever to appear on *The New York Times* bestseller list. Another development has been the demonstration that GMA predicts both later occupational level and performance within one's chosen occupation—and predicts both outcomes more strongly than any other trait. These latter two developments are the subject of this article. Because of the vastness of this literature and space limitations, our review of necessity cannot be exhaustive. However, we address the major conclusions in this literature and we cite a representative sample of the relevant research.

The remainder of this article is organized as follows. First, we present the evidence indicating that GMA predicts occupational level attained. We then review the research evidence showing that GMA predicts performance within jobs and occupations—both performance in learning the job (training performance) and performance on the job—for both civilian and military occupations. Third, we examine other traits and variables that affect training and job performance—personality traits, specific aptitudes, and job experience—and show that these factors, although important, exert weaker effects on both occupational level and job performance than does GMA. Last, we describe a theory of job performance that explains these findings.

## GMA and Attainment of Occupational Level

### *Cross-Sectional Studies*

Both cross-sectional and longitudinal studies have related GMA to occupational level. We first examine cross-sectional studies.

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People's rankings or ratings of the occupational level or prestige of different occupations are very reliable; correlations between mean ratings across studies are in the .95 to .98 range, regardless of the social class, occupation, age, or country of the raters (Dawis, 1994; Jensen, 1980, pp. 339–347). These occupational level ratings correlate between .90 and .95 with average GMA scores of people in the occupations (Jensen, 1998, p. 293). Individual level correlations are of course not this large. In the U.S. Employment Service's large database on the General Aptitude Test Battery (GATB; Hunter, 1980), the individual level correlation between the GMA measure derived from that battery and occupational level is .65 (.72 corrected for measurement error; Jensen, 1998). Much military data exist from both world wars (when samples of draftees were very representative of the U.S. male population) showing an increase in mean GMA scores as occupational level (as determined by ratings of the sort discussed here) increases (Harrell & Harrell, 1945; Stewart, 1947; Yerkes, 1921). Table 1, showing findings for 18,782 White enlisted men in the Army Air Force Command (Harrell & Harrell, 1945), presents typical findings. The GMA measure used was the Army General Classification Test (Schmidt, Hunter, & Pearlman, 1981). Mean GMA scores clearly increase with occupational level. It is also apparent that standard deviations and score ranges decrease with increasing occupational level, indicating that although lower level occupations can and do contain very high-scoring individuals, individuals with low GMA scores apparently find it hard to enter higher level occupations. It is apparent that the upper end of the GMA range is quite similar across all occupations, whereas the lower end increases with increasing occupational level, suggesting minimum GMA requirements for higher level occupations.

### *Longitudinal Studies*

Longitudinal studies are important because they show that GMA measured earlier in life predicts later occupational attainment. Wilk, Desmarais, and Sackett (1995), using the 3,887 young adults in the National Longitudinal Survey—Youth Cohort (NLSY; Center for Human Resource Research, 1989) for whom the required data were available, showed that over the 5-year period from 1982 to 1987, GMA measured in 1980 predicted movement in the job hierarchy. Those with higher GMA scores in 1980 moved up the hierarchy, whereas those with lower GMA scores moved down in the hierarchy. In a larger follow-up study that was based on somewhat different methodology, Wilk and Sackett (1996) examined two large government databases: the National Longitudinal Study of the Class of 1972 (NLS-72) and the National Longitudinal Survey of Labor Market Experience—Youth Cohort (NLSY). In both databases, Wilk and Sackett found that job mobility was predicted by the congruence between individuals' GMA scores (measured several years earlier) and the objectively measured complexity of their jobs. If their GMA exceeded the complexity level of their job, they were likely to move into a higher complexity job. And if the complexity level of their job exceeded their GMA level, they were likely to move down into a less complex job. The job complexity measure used is highly correlated with the measures of occupational level discussed above.

In another study drawn from this same large database, Murray (1998) found that GMA predicted later income even with unusually thorough control for socioeconomic status (SES) and other background variables. This control took advantage of the large variability of GMA within families and was achieved by use of a sample of male full biological siblings, hence controlling for home background and many other variables (e.g., schools, neighborhoods). Murray found that the siblings with higher GMA scores received more education, entered more prestigious occupations, had higher income, and were employed more regularly. When the siblings were in their late 20s (in 1993), a person with average GMA was earning on average almost $18,000 less per year than his brighter sibling who had an IQ of 120 or higher and was earning more than $9,000 more than his duller sibling who had an IQ of less than 80. This pattern of findings held up even in a subsample of persons who were all from "advantaged" homes (his "utopian" sample). This addresses the objection that it may not be GMA per se that causes differences in occupational level and income but other variables such as quality of schools, availability of opportunities, and so on, that are not well captured by standard measures of SES and, hence, are not fully controlled for when standard measures of SES are statistically partialed out.

Judge, Higgins, Thoresen, and Barrick (1999) related GMA measures taken at around 12 years of age to occupational outcomes in the age range of 41 to 50 years. They found that childhood GMA scores predicted adult occupational level with a correlation of .51 and predicted adult income with a correlation of .53. Ball (1938) found that GMA measured in childhood correlated .47 with occupational level 14 years later and .71 with occupational level 19 years later. Other such studies include Brown and Reynolds (1975), Dreher and Bretz (1991), Gottfredson and Crouse (1986), Howard and Bray (1990), Siegel and Ghiselli (1971), and Thorndike and Hagen (1959).

It is clear that GMA is related to occupational level (and income) longitudinally as well as cross-sectionally. Furthermore, the relationship is relatively strong. Correlations of .50 or higher are rare in psychology and the social sciences and are considered large (Cohen & Cohen, 1988). As discussed in the section *Personality and Job Performance,* certain personality traits are also predictive of occupational level, but the magnitude of the relationships is considerably smaller, with the possible exception of one personality trait (conscientiousness).

GMA predicts one's ultimate attained job level, but it does not predict which occupation at that level one will enter. That role falls to interests. There is considerable evidence that interests predict the particular occupation (or at least the occupational family) that a person will choose (Holland, 1985, 1996; Savickas & Spokane, 1999). However, interests are poor predictors of performance once one has entered an occupation (Schmidt & Hunter, 1998).

## GMA and Performance Within Occupations and Jobs

In the world of work, and particularly in the hiring of employees, measures of GMA have been used since the end of World War I (Yerkes, 1921). The tests used are typically paper-and-pencil tests containing questions and problems related to verbal material, quantitative material, spatial material, and sometimes mechanical material. Although there are a variety of such instruments, probably the most representative of these—and certainly the most widely used today—is the Wonderlic Personnel Test (Hunter, 1989; Wonderlic, 1992). This test is given with a time limit of 10 min and consists of 50 free-response items, with verbal, quantita-

Table 1
*Mean GCT Standard Scores, Standard Deviations, and Range of Scores of 18,782 AAF White Enlisted Men by Civilian Occupation (From Harrell & Harrell, 1945, pp. 231–232)*

| Occupation | *N* | *M* | *Mdn* | *SD* | Range |
|---|---|---|---|---|---|
| Accountant | 172 | 128.1 | 128.1 | 11.7 | 94–157 |
| Lawyer | 94 | 127.6 | 126.8 | 10.9 | 96–157 |
| Engineer | 39 | 126.6 | 125.8 | 11.7 | 100–151 |
| Public-relations man | 42 | 126.0 | 125.5 | 11.4 | 100–149 |
| Auditor | 62 | 125.9 | 125.5 | 11.2 | 98–151 |
| Chemist | 21 | 124.8 | 124.5 | 13.8 | 102–153 |
| Reporter | 45 | 124.5 | 125.7 | 11.7 | 100–157 |
| Chief clerk | 165 | 124.2 | 124.5 | 11.7 | 88–153 |
| Teacher | 256 | 122.8 | 123.7 | 12.8 | 76–155 |
| Draftsman | 153 | 122.0 | 121.7 | 12.8 | 74–155 |
| Stenographer | 147 | 121.0 | 121.4 | 12.5 | 66–151 |
| Pharmacist | 58 | 120.5 | 124.0 | 15.2 | 76–149 |
| Tabulating-machine operator | 140 | 120.1 | 119.8 | 13.3 | 80–151 |
| Bookkeeper | 272 | 120.0 | 119.7 | 13.1 | 70–157 |
| Manager, sales | 42 | 119.0 | 120.7 | 11.5 | 90–137 |
| Purchasing agent | 98 | 118.7 | 119.2 | 12.9 | 82–153 |
| Manager, production | 34 | 118.1 | 117.0 | 16.0 | 82–153 |
| Photographer | 95 | 117.6 | 119.8 | 13.9 | 66–147 |
| Clerk, general | 496 | 117.5 | 117.9 | 13.0 | 68–155 |
| Clerk–typist | 468 | 116.8 | 117.3 | 12.0 | 80–147 |
| Manager, miscellaneous | 235 | 116.0 | 117.5 | 14.8 | 60–151 |
| Installer–repairman, tel. & tel. | 96 | 115.8 | 116.8 | 13.1 | 76–149 |
| Cashier | 111 | 115.8 | 116.8 | 11.9 | 80–145 |
| Instrument repairman | 47 | 115.5 | 115.8 | 11.9 | 82–141 |
| Radio repairman | 267 | 115.3 | 116.5 | 14.5 | 56–151 |
| Printer, job pressman, lithographic pressman | 132 | 115.1 | 116.7 | 14.3 | 60–149 |
| Salesman | 494 | 115.1 | 116.2 | 15.7 | 60–153 |
| Artist | 48 | 114.9 | 115.4 | 11.2 | 82–139 |
| Manager, retail store | 420 | 114.0 | 116.2 | 15.7 | 52–151 |
| Laboratory assistant | 128 | 113.4 | 114.0 | 14.6 | 76–147 |
| Tool-maker | 60 | 112.5 | 111.6 | 12.5 | 76–143 |
| Inspector | 358 | 112.3 | 113.1 | 15.7 | 54–147 |
| Stock clerk | 490 | 111.8 | 113.0 | 16.3 | 54–151 |
| Receiving and shipping clerk | 486 | 111.3 | 113.4 | 16.4 | 58–155 |
| Musician | 157 | 110.9 | 112.8 | 15.9 | 56–147 |
| Machinist | 456 | 110.1 | 110.8 | 16.1 | 38–153 |
| Foreman | 298 | 109.8 | 111.4 | 16.7 | 60–151 |
| Watchmaker | 56 | 109.8 | 113.0 | 14.7 | 68–147 |
| Airplane mechanic | 235 | 109.3 | 110.5 | 14.9 | 66–147 |
| Sales clerk | 492 | 109.2 | 110.4 | 16.3 | 42–149 |
| Electrician | 289 | 109.0 | 110.6 | 15.2 | 64–149 |
| Lathe operator | 172 | 108.5 | 109.4 | 15.5 | 64–147 |
| Receiving & shipping checker | 281 | 107.6 | 108.9 | 15.8 | 52–151 |
| Sheet metal worker | 498 | 107.5 | 108.1 | 15.3 | 62–153 |
| Lineman, power and tel. & tel. | 77 | 107.1 | 108.8 | 15.5 | 70–133 |
| Assembler | 498 | 106.3 | 106.6 | 14.6 | 48–145 |
| Mechanic | 421 | 106.3 | 108.3 | 16.0 | 60–155 |
| Machine-operator | 486 | 104.8 | 105.7 | 17.1 | 42–151 |
| Auto serviceman | 539 | 104.2 | 105.9 | 16.7 | 30–141 |
| Riveter | 239 | 104.1 | 105.3 | 15.1 | 50–141 |
| Cabinetmaker | 48 | 103.5 | 104.7 | 15.9 | 66–127 |
| Upholsterer | 59 | 103.3 | 105.8 | 14.5 | 68–131 |
| Butcher | 259 | 102.9 | 104.8 | 17.1 | 42–147 |
| Plumber | 128 | 102.7 | 104.8 | 16.0 | 56–139 |
| Bartender | 98 | 102.2 | 105.0 | 16.6 | 56–137 |
| Carpenter, construction | 451 | 102.1 | 104.1 | 19.5 | 42–147 |
| Pipe-fitter | 72 | 101.9 | 105.2 | 18.0 | 56–139 |
| Welder | 493 | 101.8 | 103.7 | 16.1 | 48–147 |
| Auto mechanic | 466 | 101.3 | 101.8 | 17.0 | 48–151 |
| Molder | 79 | 101.1 | 105.5 | 20.2 | 48–137 |
| Chauffer | 194 | 100.8 | 103.0 | 18.4 | 46–143 |
| Tractor driver | 354 | 99.5 | 101.6 | 19.1 | 42–147 |
| Painter, general | 440 | 98.3 | 100.1 | 18.7 | 38–147 |
| Crane-hoist operator | 99 | 97.9 | 99.1 | 16.6 | 58–147 |
| Cook and baker | 436 | 97.2 | 99.5 | 20.8 | 20–147 |

Table 1 (*continued*)

| Occupation | *N* | *M* | *Mdn* | *SD* | Range |
|---|---|---|---|---|---|
| Weaver | 56 | 97.0 | 97.3 | 17.7 | 50–135 |
| Truck driver | 817 | 96.2 | 97.8 | 19.7 | 16–149 |
| Laborer | 856 | 95.8 | 97.7 | 20.1 | 26–145 |
| Barber | 103 | 95.3 | 98.1 | 20.5 | 42–141 |
| Lumberjack | 59 | 94.7 | 96.5 | 19.8 | 46–137 |
| Farmer | 700 | 92.7 | 93.4 | 21.8 | 24–147 |
| Farmhand | 817 | 91.4 | 94.0 | 20.7 | 24–141 |
| Miner | 156 | 90.6 | 92.0 | 20.1 | 42–139 |
| Teamster | 77 | 87.7 | 89.0 | 19.6 | 46–145 |

*Note.* GCT = General Classification Test; AAF = Army Air Force; tel. & tel. = telephone and telegraph.

tive, and spatial material about equally represented. The Wonderlic test has numerous psychometrically parallel forms available, and it is supplied with extensive norm data. On the basis of instruments of this sort, thousands of validity studies have accumulated since the early part of the 20th century.

It has long been believed among both psychologists and laypeople that GMA is important for academic performance but has little to do with real-world performances after schooling is over. In particular, it was held that GMA had little relation to performance on the job (e.g., Jencks, 1972). Within industrial–organizational psychology, a related but not identical belief was dominant between 1910 and about 1980: the so-called theory of situational specificity. This theory held that GMA did predict job performance but only sporadically; that is, it held that the validity of GMA (and other measures) for predicting job performance was highly situational: It might predict for one job in one employment setting but fail to do so for what was apparently the same job in another organization. This theory was supported by the finding that observed validity coefficients for similar tests and jobs varied substantially across different validity studies and the finding that some (about half) of these validity coefficients were statistically significant and the rest were not. The explanation offered for this puzzling variability was that jobs that appeared to be the same actually differed in important but subtle ways in what was required to perform them. Because of this, validity had to be estimated anew in each separate setting. Over the last 25 years, application of meta-analysis methods (Hunter & Schmidt, 1990) to validity databases has disconfirmed this theory and has shown that the variability in validity findings is mostly due to statistical and measurement artifacts such as sampling error variance, measurement error in job performance measures, restriction in range on GMA scores, and other artifacts. These artifacts have two effects beyond the creation of variability in observed validities: They reduce statistical power to around .50 and they bias validity estimates downward (except for sampling error, which does not exert a downward bias). After correction for the effects of these methodological artifacts, it was found that there was little or no variation in validity findings (cf. Schmidt et al., 1993) and that GMA measures were predictive of job performance (in varying degrees) for all jobs. (Similar findings of minimal actual variability under conditions of large apparent variability have also been reported in other research areas; cf. Schmidt, 1992.) Hundreds of such meta-analyses (called validity generalization studies) have now been conducted (Schmidt & Hunter, 1998) and have included a wide variety of measures used to predict job performance: aptitudes, personality traits, and other measures, in addition to GMA measures.

Results for GMA are typified by the findings of the large study conducted by Hunter (1980; Hunter & Hunter, 1984) for the U.S. Employment Service using the database on the General Aptitude Test Battery (GATB). On the basis of 425 validity studies ($N$ = 32,124) conducted on civilian jobs spanning the occupational spectrum, Hunter and Hunter (1984) and Hunter (1980) reported the results shown in Table 2. Hunter assigned each job to one of five job families based on *complexity* (i.e., the information processing requirements of the job, measured using U.S. Department of Labor job analysis data for each job). This is the largest database available using a measure of performance on the job (measured using supervisory ratings of job performance). As can be seen, validity for predicting performance on the job ranges from .58 for the highest complexity jobs (professional, scientific, and upper

Table 2
*Validity of the General Mental Ability (GMA) Measure in the General Aptitude Test Battery*

| Complexity level of job[a] | % of workforce | Performance measures: On the job | Performance measures: In training |
|---|---|---|---|
| 1 | 14.7 | .58 | .59 |
| 2 | 2.5 | .56 | .65 |
| 3 | 62.7 | .51 | .57 |
| 4 | 17.7 | .40 | .54 |
| 5 | 2.4 | .23 | NR |

*Note.* For the lowest complexity job category, no training performance studies were reported. Performance on the job was measured using supervisory ratings of overall job performance. Training performance was typically assessed using tests measuring amount learned in training. There were 425 studies of job performance ($N$ = 32,124) and 90 studies of performance in training programs ($N$ = 6,496). Correlations are corrected for measurement error in the dependent variable and for range restriction but not for measurement error in the GMA measure; hence, these are estimates of operational validities, not construct-level correlations. Construct-level correlations are approximately 8.5% larger. All values reported are mean values; after correction for artifacts, variability around these mean values was limited, and almost all values in each distribution were positive and substantial. NR = not reported. Adapted from Hunter (1980) and from "Validity and Utility of Alternate Predictors of Job Performance," by J. E. Hunter and R. F. Hunter, 1984, *Psychological Bulletin*, *96*, Table 2, p. 82. Copyright 1984 by the American Psychological Association.
[a] 1 = highest; 5 = lowest.

management jobs) to .23 at the lowest complexity level (feeding/off-bearing jobs). Job Family 2 (2.5% of all jobs in the economy) consists of complex technical jobs such as computer-systems trouble shooting or complex manufacturing set-up jobs. Job Family 3, with almost 63% of all jobs in the economy, includes skilled workers, technicians, mid-level administrators, paraprofessionals, and similar jobs. Job Family 4 is semiskilled work. Clearly, GMA predicts performance on higher level jobs better that it does for lower level jobs. However, there is substantial validity for all job levels. In particular, GMA predicts performance even for the simplest 2.4% of jobs (Job Family 5).

Other findings are reported in Table 3. On the basis of 194 studies ($N = 17{,}539$) of performance in clerical jobs, Pearlman, Schmidt, and Hunter (1980) reported a mean GMA validity for job performance of .52. For law enforcement jobs, Hirsh, Northrup, and Schmidt (1986) reported a mean validity for job performance of .38. In a large scale, multiyear military study on enlisted Army personnel (called "Project A"), McHenry, Hough, Toquam, Hanson, and Ashworth (1990) reported that GMA predicted "Core Technical Proficiency" with a validity of .63 and "General Soldiering Performance" with a validity of .65. Both job performance measures were based on hands-on work-sample measures. (Validities were not as high for ratings of "Effort and Leadership" [.31], "Personal Discipline" [.16], and "Physical Fitness and Military Bearing [.20], which are secondary criterion measures with fewer cognitive demands.) Using similar job sample measures of job performance, Ree, Earles, and Teachout (1994) reported a mean value of .45 across seven Air Force jobs.

Validities for the prediction of performance in training programs are even larger. As can be seen in Table 2, in the GATB training database (90 studies; $N = 6{,}496$) used by Hunter and Hunter (1984), GMA predicted performance in job training programs for all job families for which data existed with a correlation above .50. The database for training performance is larger for military jobs. Hunter (1986) meta-analyzed military databases totaling over 82,000 trainees and reported an average validity of .63 for GMA. On the basis of 77,958 Air Force trainees, Ree and Earles (1991) reported a very similar value of .60. On the basis of 65 studies with an $N$ of 32,157, Pearlman et al. (1980) reported a mean validity of .71 for GMA in predicting training performance of clerical workers, whereas Hirsh et al. (1986) found a mean value of .76 for predicting performance in police and other training academies for law enforcement trainees. These findings and others are shown in Table 3. Additional data of this sort are presented in Schmidt (2002).

A rough summary can be obtained by averaging the findings shown in Table 3. Across the meta-analyses reported there, the unweighted average validity of GMA is .55 for predicting performance on the job and .63 for predicting performance in job training programs.

## Other Traits and Variables That Affect Job Performance

Variables beyond GMA that have been hypothesized to affect job and training performance include specific aptitudes (e.g., verbal ability, quantitative ability, etc.), job experience, and personality traits.

### *Specific Aptitudes and Specific Aptitude Theory*

Cognitive abilities that are narrower than GMA are called specific aptitudes, or often just aptitudes. Examples include verbal

Table 3
*The Relation Between General Mental Ability (GMA) and Performance in Job Training and on the Job: Representative Findings From Meta-Analyses*

| | | Performance measures | |
|---|---|---|---|
| Study | Occupation | On the job | In training |
| Hunter and Hunter (1984) | Medium complexity[a] | .51 | .57 |
| Pearlman et al. (1980) | Clerical | .52 | .71 |
| Hirsh et al. (1986) | Law enforcement | .38 | .76 |
| McHenry et al. (1990) | Military—enlisted | .63[b] | NR |
| McHenry et al. (1990) | Military—enlisted | .65[c] | NR |
| Hunter (1986) | Military—enlisted | NR | .63 |
| Ree et al. (1994) | Military—enlisted | .45 | NR |
| Ree and Earles (1991) | Military—enlisted | NR | .60 |
| Schmidt et al. (1979) | First-line supervisors | .64 | NR |
| Schmidt et al. (1979) | Administrative clerks | .67 | NR |
| Schmidt et al. (1980) | Computer programmers | .73 | NR |
| Callender and Osburn (1981) | Refinery workers | .31 | .50 |

*Note.* McHenry et al. (1990) and Ree et al. (1994) used job sample measures of job performance. Other studies measured job performance using supervisory ratings of overall job performance. Training performance was typically measured using tests of amount learned in the training program. Correlations are corrected for measurement error in the dependent variable and for range restriction but not for measurement error in the GMA measures; hence, these are estimates of the operational validities, not construct-level correlations. Construct-level correlations are 8% to 12% larger. All values reported are mean values; after correction for artifacts, variability around these mean values was limited and almost all values in each distribution were positive and substantial. NR = not reported. (i.e., the relationship was not examined in the study).
[a] Results for medium-complexity jobs (63% of jobs). Results for other job complexity levels are given in Table 2. [b] Criterion was "core technical proficiency." [c] Criterion was "general soldiering proficiency."

aptitude, spatial aptitude, and numerical aptitude. Differential or specific aptitude theory hypothesizes that performance on different jobs requires different cognitive aptitudes and, therefore, regression equations computed for each job and incorporating measures of several specific aptitudes will optimize the prediction of performance on the job and in training. In the last 10 years, research has strongly disconfirmed this theory. Differentially weighting specific aptitude tests produces little or no increase in validity over the use of a measure of GMA. An explanation for this finding has been discovered. It has been found that specific aptitude tests measure GMA; in addition to GMA, each measures something specific to that aptitude (e.g., specifically numerical aptitude, over and above GMA). The GMA component appears to be responsible for the prediction of job and training performance, whereas the factors specific to the aptitudes appear to contribute little or nothing to prediction. The research showing this is presented and reviewed in Hunter (1986); Jensen (1986); Thorndike (1986); Olea and Ree (1994); Ree and Earles (1992); Ree et al. (1994); Schmidt, Ones, and Hunter (1992); and Sackett and Wilk (1994), among other sources.

A particularly dramatic refutation of specific aptitude theory comes from the large sample military research conducted by Hunter (1983b) for the Department of Defense on the performance of military personnel in job training programs. Four large samples were analyzed separately: 21,032 Air Force personnel, 20,256 Marines, and two Army samples of 16,618 and 79,926, respectively. In all samples, test data were obtained some months prior to measurement of performance in job training programs. In all samples, causal analysis modeling (with corrections for measurement error and range restriction) was used to pit specific aptitude theory against GMA in the prediction of performance. In the case of all four samples, models with causal arrows from specific aptitudes to training performance failed to fit the data. However, in all the samples, a hierarchical model showing a single causal path from GMA to performance—and no paths from specific aptitudes to performance—fit the data quite well. Figure 1 shows the findings for the Marines sample. The causal model that fit the data shows GMA as the cause of the specific aptitudes of quantitative, verbal, and technical (i.e., these specific aptitudes were indicators—or measures—of GMA). Specific subtests of the Armed Services Vocational Aptitude Battery (ASVAB, Forms 6/7) were, in turn, caused by these three specific aptitudes (i.e., they were indictors of these aptitudes). For example, the Math Knowledge and Arithmetic Reasoning subtests were indicators of quantitative aptitude. There is no causal arrow from any of the aptitudes or subtests to training performance. Training performance is determined only by GMA, with the standardized path coefficient from GMA to performance being very large (.62). The findings for the other three samples were essentially identical (Hunter, 1983b).

It is well known that analysis of causal models with correlational data cannot prove a theory. However, such analyses—especially when samples are very large, as here—can disconfirm theories. Theories that do not fit the data are disconfirmed. In these studies, specific aptitude theory is strongly disconfirmed.

### Job Experience, GMA, and Job Performance

Learning, and hence job experience, plays a major role in the determination of job performance. Experience provides the medium for learning, and, thus, people with more experience have had more opportunity to learn and to achieve a higher level of job performance (Schmidt, Hunter, & Outerbridge, 1986).

However, individual differences in learning are also important. If one worker learns faster than another, the same amount of experience will produce a higher level of performance in the fast learner than in the slow learner. It is GMA that turns experience into increased job knowledge and hence higher performance.

### *Ability Differences Over Time*

One might hypothesize that the validity of GMA declines over time as workers obtain more job experience. However, research does not support this hypothesis. Schmidt, Hunter, Outerbridge, and Goff (1988) analyzed data for four military occupations in which workers had been assessed for job knowledge, objectively measured actual performance, and performance ratings. Their data allowed mean comparisons between high and low GMA groups (upper and lower halves of the distribution) for each year of experience out to 5 years. For job knowledge, Schmidt et al. (1988) found large and constant differences between the two ability

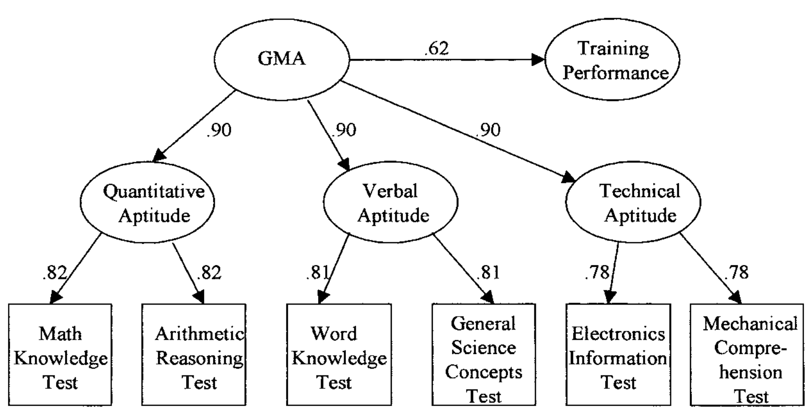


*Figure 1.* The standardized path model for the U.S. Marine data ($N$ = 20,256) from Hunter (1983b) showing relationships among general mental ability (GMA), specific aptitudes, and subtests of the Armed Services Vocational Aptitude Battery (Forms 6/7). Adapted from Hunter (1983b).

groups at all levels of experience over the 5-year period. For objectively measured job performance, the same finding was observed. For performance ratings, Schmidt et al. found definite though smaller differences between the two ability groups at all levels of experience up to 5 years. Again, the size of the difference was the same after 5 years as after 1 year of experience.

McDaniel (1985) analyzed United States Employment Services (USES) data for groups whose level of job experience extended beyond 5 years. Controlling for differences in variability of GMA across groups, McDaniel correlated GMA with performance ratings for each level of experience to 12 years and up. The results are summarized in Table 4. As the level of experience increases, the predictive validity does not decrease. Validity goes from .36 for 0–6 years, up to .44 for 6–12 years, up to .59 for more than 12 years (although the last value is based on a very small sample). If anything, McDaniel's data suggest an increase in the validity of GMA for predicting performance ratings as level of worker experience increases.

These findings indicate that the predictive validity of GMA is at least stable over time and does not decrease. The work of Ackerman (1986, 1987, 1988, 1990, 1992) has been the basis for predictions of declining GMA validities over time. Ackerman distinguished between consistent tasks and inconsistent tasks. Consistent tasks are simple enough (or noncognitive enough) that their performance can be automated; hence, after a time, such tasks draw minimally on cognitive resources and performance on such tasks comes over time to show a low correlation with GMA (e.g., riding a bicycle). Inconsistent tasks are just the opposite: They are complex enough that no matter how long they are performed, they continue to draw on cognitive resources (and to require controlled information processing), and they therefore continue to show a large correlation with GMA over time. Using a variety of tasks in laboratory research, Ackerman (1987) has provided evidence to support his theory of controlled and automated information processing. On the basis of Ackerman's theory and research, Murphy (1989) advanced a theory that predicts declining validity over time for GMA in predicting job performance. (Ackerman himself has not made such a prediction.) Murphy's theory posits *maintenance stages*, during which job tasks are well learned and can be performed with minimal mental effort (automatic information processing), resulting in low or zero GMA validities. The empirical evidence summarized above disconfirms this theory and suggests that when the measure in question is overall job performance, the task remains complex enough that it cannot be automated; it continues to require controlled information processing and hence continues to correlate with GMA (Schmidt et al., 1992). There may be a temptation in this area to generalize inappropriately from narrow and automatable tasks to broader, more complex, and less automatable real-world job performance composites.

Table 4
*The Correlation Between General Mental Ability (GMA) and Job Performance Ratings for Job Incumbents With Various Levels of Job Experience*

| Years of experience | Total sample size | GMA with performance correlation |
|---|---|---|
| 0–3 | 4,424 | .35 |
| 3–6 | 3,297 | .37 |
| 6–9 | 570 | .44 |
| 9–12 | 84 | .44 |
| 12+ | 22 | .59 |

*Note.* From *The Evaluation of a Causal Model of Job Performance: The Interrelationships of General Mental Ability, Job Experience, and Job Performance* (p. 76), by M. A. McDaniel, 1985, unpublished doctoral dissertation, George Washington University. Adapted with permission of the author.

### *Predictive Validity of Job Experience*

Hunter and Hunter (1984) found the mean predictive validity of job experience to be .18 across 373 studies (corrected for measurement error in the job performance ratings). Controlling for differences in variability of experience across categories of experience, McDaniel, Schmidt, and Hunter (1988) examined the validity of job experience at different mean levels of experience using the USES individual worker database. The results are summarized in Table 5. Some training advocates hypothesize that experience differences become increasingly important as workers become more and more experienced. The pattern of findings in Table 5 is opposite to the prediction from this hypothesis. Differences in experience are very important among newly hired employees: The correlation between experience and performance ratings is .49 for those who have been on the job 0–3 years. (Schmidt et al., 1986, likewise found substantial correlations between job experience and performance when all workers were on the low end of the experience continuum [less than 5 years]. The mean value for supervisory ratings was .33, and for work sample measures of performance it was .47.) This correlation then drops gradually to a low of .15 for those who have been on the job 12 years or more. This is explained by other data presented in McDaniel (1985) showing the nonlinear relationship between experience and performance. The relation between experience and job performance shows the same shape as other learning curves: It is nonlinear and monotonic (Schmidt & Hunter, 1992; Schmidt et al., 1988).

### *Ability Versus Experience as Predictors*

Tables 4 and 5 show that as workers gain job experience, the correlation between experience and performance decreases whereas the correlation between GMA and performance remains constant or increases. GMA not only matters during the early stages of job learning but throughout the worker's tenure. This pattern may be even more pronounced today because of the rapidly changing product life cycles that require workers to learn new methods of production at ever shorter intervals.

## *Personality and Job Performance*

In our experience, laypeople consider personality a more important determinant of job performance than GMA. It is easy to think of individuals who experienced difficulty at work because of personality conflicts with supervisors or because of failure to be organized and achievement oriented at work. Many people may also believe that personality is more important than GMA in determining ultimate occupational level. However, research sup-

Table 5
*The Correlation Between Amount of Job Experience and Performance Ratings for Job Incumbents With Various Levels of Job Experience*

| Years of experience | Total sample size | Experience with performance correlation |
|---|---|---|
| 0–3 | 4,490 | .49 |
| 3–6 | 5,088 | .32 |
| 6–9 | 3,588 | .25 |
| 9–12 | 1,274 | .19 |
| 12+ | 1,618 | .15 |

*Note.* Differences in variability of experience across categories of experience were controlled for. From "Job Experience Correlates of Job Performance," by M. A. McDaniel, F. L. Schmidt, and J. E. Hunter, *Journal of Applied Psychology, 73*, p. 329. Copyright 1988 by the American Psychological Association.

ports the conclusion that personality is less important than GMA in both areas.

In recent years, most personality research has been organized around the Big Five model of personality (Goldberg, 1990). Considerable evidence has accumulated suggesting that most personality measures intended for individuals without psychopathology can be subsumed under the umbrella of the five-factor model. The five traits included in this model are Extroversion, Agreeableness, Neuroticism, Openness to Experience, and Conscientiousness. These same five personality factors have been found in analyses of trait adjectives in a variety of different languages, factor-analytic studies of existing personality inventories, and decisions regarding the dimensionality of existing measures made by expert judges (McCrae & John, 1992). The five-factor structure has been found in a wide variety of cultures (McCrae & Costa, 1997; Pulver, Allik, Pulkkinen, & Hamalainen, 1995; Salgado, 1997; Yoon, Schmidt, & Ilies, 2002) and remains stable over time (Costa & McCrae, 1988, 1991). Although the five-factor model of personality has its critics (e.g., see Block, 1995; Butcher & Rouse, 1996), it is widely accepted today.

As indicated earlier, Judge et al. (1999) found that three of the Big Five personality traits measured in childhood predicted adult occupational level and income. For Conscientiousness, these longitudinal correlations were .49 and .41, respectively; these values are only slightly smaller than the corresponding correlations in this study for GMA (discussed in the *Longitudinal Studies* section, above) of .51 and .53, respectively. For Openness to Experience (which correlates positively with GMA), the correlations were .32 and .26. Finally, Neuroticism produced longitudinal correlations of –.26 and –.34, for occupational level and income, respectively.

Because of the unique nature of Judge et al.'s (1999) study, we conducted additional analyses of the data from this study. Because occupational level and income were highly correlated ($r$ = .83) and loaded on the same factor, we combined them into one equally weighted measure of career success. After correcting for the biasing effects of measurement error, we found that the three Big Five personality traits predicted this index of career success with a (shrunken) multiple correlation of .56. It is interesting to examine the standardized regression weights (betas). For Neuroticism, $\beta$ = –.05 (*SE* = .096); for Openness, $\beta$ = .16 (*SE* = .10); and for Conscientiousness, $\beta$ = .44 (*SE* = .123). Hence, in the regression equation, Conscientiousness is by far the most important personality variable, and Neuroticism appears to have little impact after controlling for the other two personality traits.

However, it is also important to control for the effects of GMA. When GMA is added to the regression equation, the (shrunken) multiple correlation rises to .63. Again, it is instructive to examine the beta weights: Neuroticism, $\beta$ = –.05 (*SE* = .096); Openness, $\beta$ = –.03 (*SE* = .113); Conscientiousness, $\beta$ = .27 (*SE* = .128); and GMA, $\beta$ = .43 (*SE* = .117). From these figures, it appears that the burden of prediction is borne almost entirely by GMA and Conscientiousness, with GMA being 59% more important than Conscientiousness (i.e., .43/.27 = 1.59). In fact, when only GMA and Conscientiousness are included in the regression equation, the (shrunken) multiple correlation remains the same, at .63. The standardized regression weights are then .29 for Conscientiousness (*SE* = .102) and .41 for GMA (*SE* = .096). These analyses suggest that Conscientiousness may be the only personality trait that contributes to career success.

As far as we were able to determine, there are no other data sets comparable with Judge et al.'s (1999) data; that is, data sets that relate both personality and ability measures to career success and are longitudinal in nature. In fact, even cross-sectional data sets that relate personality and GMA to career success are rare. This is unfortunate; it would be highly desirable to compare findings across different such longitudinal data sets.

In the prediction of performance on the job, only one of the Big Five traits—Conscientiousness—has been found in meta-analytic studies to function like GMA in that it consistently predicts job performance in all job families studied (Barrick & Mount, 1991; Mount & Barrick, 1995). The level of validity is higher when Conscientiousness is assessed using ratings by others rather than self-report personality inventories (Mount, Barrick, & Strauss, 1994). Conscientiousness also predicts performance in job training programs (Mount & Barrick, 1995; Schmidt & Hunter, 1998). In one primary study, Barrick and Mount (1993) found that the validity of Conscientiousness was higher for managers in high-autonomy jobs than for those in low-autonomy jobs. Barrick, Mount, and Strauss (1993) proposed that Conscientiousness affects motivational states and stimulates goal setting and goal commitment. They found in their primary study, which was designed to test this causal model, that Conscientiousness had both direct and indirect effects (through goal setting and commitment) on performance. They concluded that Conscientiousness functions as a motivational contributor to job performance. The traits Extroversion and Agreeableness are sporadically valid: They predict performance on certain kinds of jobs under certain conditions but are not job related for most jobs (Barrick & Mount, 1993; Barrick, Mount, & Judge, 2001; Barrick, Stewart, Neubert, & Mount, 1998). For example, Barrick et al. (1998) found that in work teams in which members must cooperate closely, Agreeableness, Extraversion, and Emotional Stability, in addition to Conscientiousness, were related to supervisor ratings of team performance.

The best meta-analytic estimate for the validity of Conscientiousness, measured with a reliable scale, for predicting job performance is .31 (Mount & Barrick, 1995). Hence, the validity of GMA is 60% to 80% larger (depending on the GMA validity estimate used) than that of Conscientiousness. However, Conscientiousness measures contribute to validity over and above the validity of GMA, because the two are uncorrelated (Schmidt &

Hunter, 1998). As noted above, Hunter and Hunter (1984) estimated the validity of GMA for medium complexity jobs (63% of all jobs) to be .51. The multiple correlation produced by use of measures of both GMA and Conscientiousness in a regression equation for such jobs is .60, an 18% increase in validity over that of GMA alone (Schmidt & Hunter, 1998). The best meta-analytic estimate of the validity of Conscientiousness for predicting performance in job training is .30 (Mount & Barrick, 1995). The multiple correlation produced by simultaneous use of GMA and Conscientiousness measures is .65 (vs. .56 for GMA alone; Schmidt & Hunter, 1998).

Integrity tests can also be considered personality measures because they have been found to measure Conscientiousness primarily, with some representation of Agreeableness and Neuroticism (reverse scored; Ones, 1993). Integrity tests have been shown to have validity for all jobs studied (Ones, Viswesvaran, & Schmidt, 1993) and to have validity that is somewhat higher than that of Conscientiousness measures (.41 for job performance and .38 for training performance). However, these validities are still considerably smaller than those for GMA. For predicting job performance, integrity tests produce a 27% increase in validity over that of GMA alone (to a multiple *R* of .65). For training performance, the increment is 20% (to a multiple *R* of .67; Schmidt & Hunter, 1998).

These findings, which are based on hundreds of studies subjected to meta-analysis, indicate that although personality (as conceptualized in the Big Five model) is indeed important in job and training performance, it is less important than GMA. Contrary to what may be the common intuition, ability is more important than personality in the workplace (Ree & Carretta, 1998; Schmidt & Hunter, 1998).

A reviewer enquired as to whether job performance is unidimensional. Performance on any job can be broken down analytically and rationally into its various component dimensions. Campbell and his associates (e.g., Campbell, McCloy, Oppler, & Sager, 1992) have identified dimensions of job performance that are general across different jobs. As they acknowledged, performance on these dimensions is likely to be positively correlated. However, even if this was not the case, one could still create and use a composite index of job performance that represents overall job performance (Schmidt & Kaplan, 1971), as was done in the validity studies reviewed in this article. In addition, there is empirical evidence that there is a general factor in job performance. Viswesvaran, Schmidt, and Ones (2002) developed a statistical method for removing from job performance ratings the halo error that inflates the correlations among rated dimensions of job performance. They found that even after this bias was removed, there was still a large general factor in job performance. The fact that GMA and Conscientiousness affect performance on all job performance dimensions is almost certainly part of the explanation for this general factor.

## Why Is GMA So Important for Job Performance?

It can be difficult for people to accept facts and findings they do not like if they see no reason why the findings should or could be true. When Alfred Weggner advanced the theory of plate tectonics early in the 20th century, geologists could think of no means by which continents or continental plates could move around. Not knowing of any plausible mechanism or explanation for the movement of continents, they found Weggner's theory implausible and rejected it. Many people have had the same reaction to the empirical findings showing the GMA is highly predictive of job performance. The finding does not seem plausible to them because they cannot think of a reason why such a strong relationship should exist. In fact, their intuition may tell them that personality and other noncognitive traits are more important than GMA (Hunter & Schmidt, 1996). However, as in the case of plate tectonics theory, there is an explanation. Causal analyses of the determinants of job performance show that the major effect of GMA is on the acquisition of job knowledge: People who are higher in GMA acquire more job knowledge and acquire it faster. The amount of job-related knowledge required on even less complex jobs is much greater than is generally realized. Higher levels of job knowledge lead to higher levels of job performance. Viewed negatively, not knowing what one should be doing—or even not knowing all that one should about what one should be doing—is detrimental to job performance. In addition, knowing what one should be doing and how to do it depends strongly on GMA.

The research showing that the major mediating link between GMA and job performance is job knowledge is described in Borman, Hanson, Oppler, and Pulakos (1993); Borman, White, Pulakos, and Oppler (1991); Hunter (1983a); Hunter and Schmidt (1996); Schmidt (2002); Schmidt and Hunter (1992); and Schmidt et al. (1986). We illustrate this research using the findings that Hunter and Schmidt (1996) reported separately for military and civilian jobs. Figure 2 shows the basic path analysis results. (The differences between military and civilian jobs are quantitative rather than qualitative and are not discussed here.) As can be seen, in both data sets, the major effect of GMA is on the acquisition of job knowledge, and job knowledge in turn is the major determinant of job performance (measured using hands-on job sample tests). GMA does have a direct effect on job performance independent of job knowledge in both data sets, but this effect is smaller than its indirect effect through job knowledge (direct effect of .31 for civilian jobs vs. an indirect effect of $.80 \times .56 = .45$; direct effect of .15 for military jobs vs. an indirect effect of $.63 \times .61 = .38$). These results also show that supervisory ratings of job performance are determined in both data sets by both job knowledge and job sample performance. Hunter and Schmidt (1996) and Schmidt and Hunter (1992) presented an extended theory that predicts and explains findings such as these.

For practical purposes of prediction in personnel selection, it does not matter why GMA predicts job performance. However, scientific understanding requires theoretical explanation. Theoretical explanation is also required to gain acceptance of findings from those who question the plausibility of a central role for GMA in the determination of job performance. It is easier to accept an empirical finding when there is a theoretical explanation for that finding.

## Summary

It has been nearly 100 years since Spearman (1904) defined the construct of GMA and proposed its central role in human cognition and learning. During the middle part of the 20th century, interest in the construct of GMA declined in some areas of psychology, but in the last 20 to 25 years there has been a resurgence of interest in

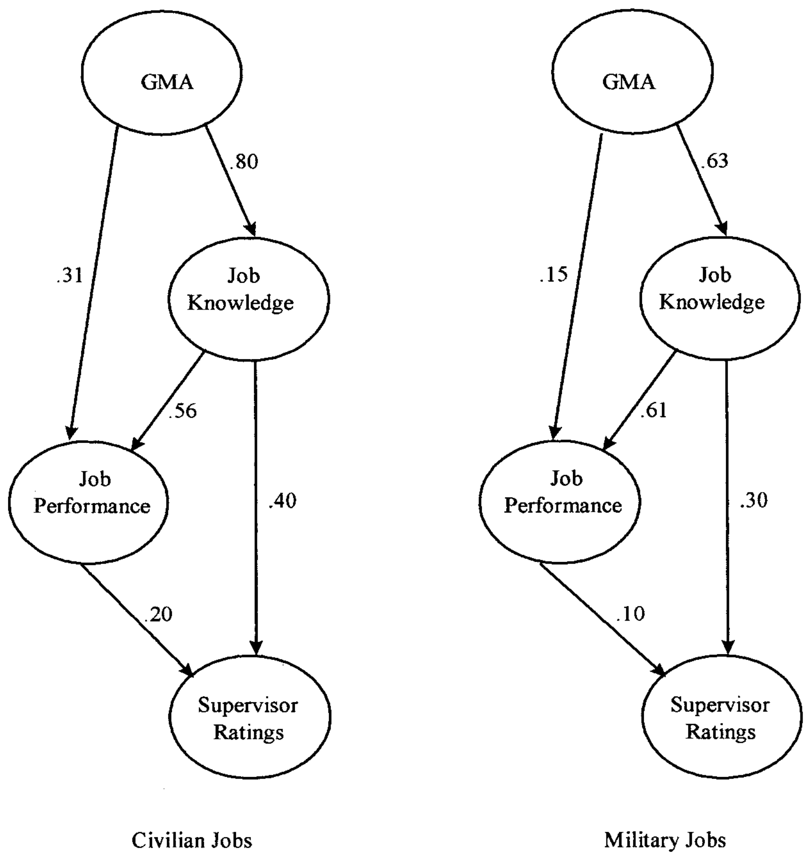


*Figure 2.* A path analysis of relations among general mental ability (GMA), job knowledge, job performance, and supervisor ratings. Reprinted from "Intelligence and Job Performance: Economic and Social Implications," by J. E. Hunter and F. L. Schmidt, 1996, *Psychology, Public Policy, and Law, 2,* Figure 1, p. 464. Copyright 1996 by the American Psychological Association.

GMA and its role in various life areas. This article has focused on the world of occupations and work and has presented the research evidence, most of it being recent, showing that GMA predicts both the occupational level attained by individuals and their performance within their chosen occupation. GMA correlates above .50 with later occupational level, performance in job training programs, and performance on the job. Relationships this large are rare in psychological research and are considered "large" (Cohen & Cohen, 1988). Other traits, particularly personality traits, also affect occupational level attained and job performance, but these relationships are generally not as strong as those for GMA. Evidence was summarized indicating that weighted combinations of specific aptitudes (e.g., verbal, spatial, or quantitative aptitude) tailored to individual jobs do not predict job performance better than GMA measures alone, thus disconfirming specific aptitude theory. It has been proposed that job experience is a better predictor of job performance than GMA, but the research findings presented in this article support the opposite conclusion. Job experience (i.e., amount of opportunity to learn the job) does relate to job performance, but this relationship is weaker than the relation with GMA and it declines over time, unlike the GMA–job performance relationship.

Empirical facts about relationships are important but are scientifically unsatisfactory without theoretical explanation. This article describes a theory that accounts for the central role of GMA in job training programs and in job performance and cites the research evidence supporting this theory.

Nearly 100 years ago, Spearman (1904) proposed that the construct of GMA is central to human affairs. The research presented in this article supports his proposal in the world of work, an area of life critical to individuals, organizations, and the economy as a whole.

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