The Challenge and Promise of Cognitive Career Assessment

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Abilities are as important as interests in career choice and development. Reviving cognitive assessment in career counseling promises to help counselees better understand their career options and how to enhance their competitiveness for the ones they prefer. Nearly a century of research on human cognitive abilities and jobs' aptitude demands in the U.S. economy reveals that the two domains are structured in essentially the same way. The author describes that common structure and how it can be used in assessing person-job match in terms of general ability level and ability profile. She also suggests ways of resolving various technical and professional questions, such as which cognitive abilities to assess, how to assess them, what the most useful aptitude-based occupational classification would be, and how to use cognitive assessments in a broader "reality-based exploration" process intended to expand people's career opportunities.

Keywords: Career assessment, cognitive abilities, career choice, aptitude requirements, occupational classification

As a graduate student in sociology in the 1970s, I was always struck by that field's dehumanized view of people: We are not really individuals but fungible beings who seek the same ends (status and power) and would "get ahead" equally were it not for the obstacles that others put in our paths. In sharp contrast, vocational psychology viewed people as unique beings, with different interests and abilities, who actively seek to implement their sense of self by their choices of career.

I was therefore puzzled by one aspect of vocational psychology—why did the field no longer pay much attention to one of the twin pillars in person-job match? Why did the career literature say so little about abilities and their role in counseling? In fact, why had it become somewhat hostile to the measurement of abilities? The reason was not that abilities lacked importance. Indeed, local community college counselors were telling me that knowing how to deal with abilities was their biggest concern. Specifically, how should they discuss abilities with counselees when helping them select majors and careers? To them, it seemed

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wrong to tell a student (and they did not) that he or she lacked the ability to pursue a stated goal (say, medical school), but nor did it seem right to withhold that judgment (which they usually did) when costly failures were certain to follow. Counselors felt "damned if they did, and damned if they didn't."

Their dilemma was the answer to my puzzle. The civil rights and women's movements had made counseling psychologists reluctant to tell counselees they could not become whatever they wished to be. The field had also become averse to using any assessment that yields different answers, on the average, to different demographic groups—which most do. A brief war erupted over purported sex bias in interest measurement in the late 1970s, as the field struggled with male-female differences in interest profiles. But vocational interests have the advantage of being different in kind, not level. I can be just as delighted with my "vocational personality" score as you are with yours, even when they represent opposite corners on Holland's hexagonal model of interests, say, investigative versus enterprising. You and I may differ dramatically, but neither is better. We may pursue different paths—science versus the law—but both are bright with opportunity for success.

The picture is different with abilities, however, because being different usually means being stronger or weaker. We might not mind learning that one of us has a distinctly quantitative profile and the other a verbal one, or even that neither of us can carry a tune, but neither of us wants to learn that we score below average in academic ability or general intelligence. Counselors are understandably no more eager to transmit such information than we are to receive it, precisely because of its seeming importance. Low general ability does not promise a different type of success but a struggle to succeed.

But what do we really know about abilities? Might they simply be the product of opportunity, interest, and effort? Can they be measured without cultural bias? Which ones, if any, actually predict career choice, performance, and satisfaction? These are empirical questions about which allied fields have provided much new information in recent decades. If we are to revive cognitive assessment, as I believe we should, any revival will enhance career counseling only if it is firmly and confidently grounded in fact, not fear or fancy. I will therefore highlight what has been learned in recent decades about human cognitive abilities and, just as important, about the cognitive abilities that occupations actually require for good performance.

Knowing these facts does not tell us how to use them wisely. It was, after all, confusion over how to use information about abilities that led vocational psychologists to pull back from cognitive assessment in the first place. I have spent much of the past two decades pondering the professional challenges that individual and group differences in ability pose for practitioners in both vocational counseling and employee selection. I do not pretend to have resolved these challenges, but perhaps the considerations I offer later in this article can help speed a beneficial revival of cognitive assessment in career counseling.

COGNITIVE ABILITIES

The field of human cognitive abilities is one of the oldest and most technically sophisticated in all of psychology. The following basic information can be found in any good textbook on mental abilities (e.g., Brody, 1992; Jensen, 1980, 1998; Plomin, DeFries, McClearn, & McGuffin, 2001), articles relating abilities specifically to employment (e.g., L. S. Gottfredson, 2002a; Lubinski & Dawis, 1992; Schmidt & Hunter, 1998), and publications for more general audiences (e.g., L. S. Gottfredson, 1996b, 1998, 2000).

What Is a "Cognitive Ability"?

The term *ability* refers to an attribute of individuals revealed by differences in the levels of task difficulty, on a defined class of tasks that individuals perform successfully when they have the opportunity and motivation to do well (see Carroll, 1993, pp. 3-9). For instance, there are distinct abilities in using language (verbal aptitude) and visualizing objects in three-dimensional space (spatial aptitude). Cognitive abilities involve tasks that are primarily mental and not physical. That is, they require "thinking," some mental manipulation of information or ideas. Abilities are what people can do, not their style of doing it. Abilities are not the bodies of knowledge that people amass but their aptness in amassing them.

What Is the Structure of Human Cognitive Abilities?

Vocational psychology has found it extremely useful to determine the number and relatedness—that is, the structure—of vocational interests. Knowing the structure of cognitive abilities is just as important. Whereas vocational interests are related in an hexagonal arrangement, cognitive abilities turn out to be organized in a hierarchy according to their generality-specificity. Each higher level in the hierarchy represents abilities that are more general, that is, encompass a broader range of tasks. The major levels of generality are illustrated by Carroll's (1993) three-stratum theory, which summarizes his reanalysis of more than 400 factor analytic studies on the structure of human mental abilities. Figure 1 provides a much simplified version of it.

At the lowest level, Stratum 1, are the most specific abilities assessed by standardized mental tests, such as reading decoding, memory span, and associative memory. These abilities not only are relatively narrow in scope but also tend to be complex composites of the higher order abilities, situational factors, and noncognitive traits that might influence performance on a specific type of task in particular settings. At the next higher level of generality, Stratum 2, are the well-known group factors of Ability, including verbal aptitude, spatial aptitude, and

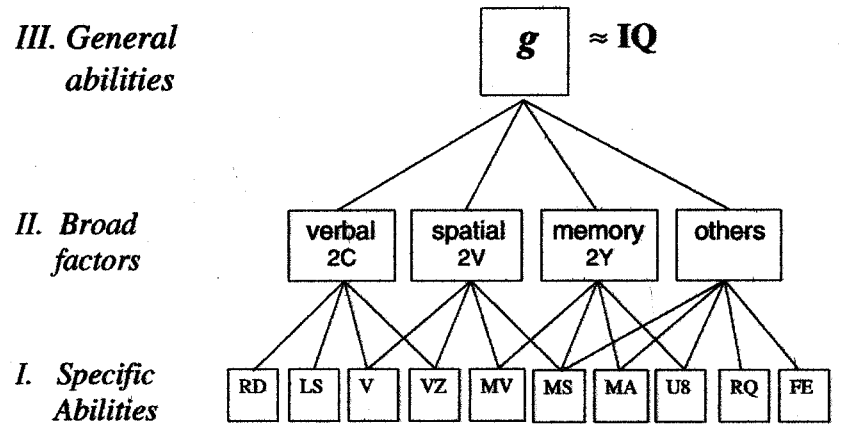

Figure 1. Hierarchical structure of cognitive abilities.

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Note. This simplified rendition of the hierarchical model draws from Carroll's (1993, chap. 15) three-stratum summary of the evidence. Verbal, spatial, and memory represent three of his eight Stratum 2 factors, respectively, Crystallized Intelligence (2C), Broad Visual Perception (2V), and General Memory and Learning (2Y). The Stratum 1 abilities sampled here are reading decoding (RD), listening ability (LS), verbal (printed) language comprehension (V), visualization (VZ), visual memory (MV), memory span (MS), associative memory (MA), maintaining and judging rhythm (U8), quantitative reasoning (RQ), and expressional fluency (FE). See Carroll (p. 626) for the five other Stratum 2 factors in his summary model, as well as for the other Stratum 1 factors that are correlated with the Stratum 2 factors shown here in Figure 1. g = general mental ability.

the like. Carroll identifies eight, including fluid intelligence (reasoning), crystallized intelligence (language), broad visual perception (spatial), general memory, and broad auditory perception. These broad abilities are somewhat distinct because each relates to aptness in performing a different class of tasks. But all the Stratum 2 abilities are also substantially correlated in any diverse sample of individuals, because all measure something in common, namely, a general mental ability to process information of any sort. In fact, research has shown that they all consist primarily of that same more fundamental ability—the Stratum 3 factor called "g" (short for the general mental ability factor). One Stratum 2 ability, fluid intelligence (reasoning), seems essentially isomorphic with g itself. IQ tests are imperfect but good measures of this most general factor, g. One of Carroll's (1993) important contributions was to reconfirm that despite the impressive variety of tests factor analyzed over the decades, only a single general factor—that is, only one Intelligence—ever emerges at the most general, Stratum 3 level. In contrast to Stratum 1 and 2 abilities, g not only encompasses the broadest range of mental tasks (apparently all of them) but also is the most psychometrically unitary (unidimensional) of the factors. (Whether it is biologically unitary has been a matter of much debate.)

Other research has revealed crucial differences among the three strata of abilities. First, the more general an ability is, the more stable and heritable it is.

Moreover, both stability and heritability increase with age, becoming fairly high by late adolescence for the broad factors. Conversely, the more specific or narrow an ability is, the more trainable and subject to shared family influences it seems to be. These facts are exceedingly important. They mean that there may be much scope for changing our narrower skills but that we must work with (rather than expect to change) our most general abilities. Research on the structure of human abilities is now turning to their genetic relatedness, focusing so far on how abilities in Strata 2 and 3 interrelate. The phenotypic (observed) correlations among them (all those examined so far) are almost entirely genetic in nature, and their genetic overlap resides almost exclusively in the same set of genes that account for g.

Second, the most general abilities are the best overall predictors of job performance. Personnel psychologists once thought that each job—indeed, each setting for a job—required its own highly specific and idiosyncratic profile of skills and abilities. That belief has now been decisively refuted. Meta-analyses have shown that the most general ability, g, predicts performance to some extent in all jobs. In contrast, Stratum 2 abilities add little to the prediction of performance above and beyond g and then only in selected groups of jobs (e.g., spatial ability in certain technical and artistic jobs, speeded tests of clerical ability in clerical jobs). Stratum 2 abilities tend to predict job performance fairly well but generally only to the extent that they also reflect g.

This is not to say that specific skills are unimportant. Far from it. This is to say only that more general abilities are more broadly useful across the great variety of tasks and settings that we encounter in the workplace. Moreover, training and experience bring out, not erase, the impact of differences in our more general abilities because they provide occasions for us to exploit those abilities. The foregoing results on predictive validity are important because they mean that low general abilities greatly constrain the range of a person's options in the workplace. Low general ability is seldom a problem among students in 4-year colleges because colleges avoid admitting them, but it is a common constraint in other populations.

A third, more recent finding qualifies the hierarchical model in a manner that directly affects career counseling: Stratum 2 abilities are highly correlated among individuals of below average IQ (g), but the correlations weaken in higher IQ populations. In other words, brighter individuals tend to have more jagged Stratum 2 ability profiles. This suggests that profile shape may add more to the prediction of performance, beyond profile level, in higher IQ populations.

A final fact should be noted. The broad cognitive abilities tend not to correlate much with either vocational interests or personality (e.g., Ackerman & Heggestad, 1997). The relative independence of the cognitive and noncognitive domains means that cognitive assessments provide useful information that cannot be obtained from the noncognitive inventories of personal traits. There are important points of overlap, as we shall see, but they are fairly localized.

But Aren't There Multiple Intelligences?

Both Gardner (1983) and Sternberg (1997) have proposed "multiple intelligences" theories. Many people infer from them that everyone can be "smart" in some way, but this is not so. Neither theorist has demonstrated that his proposed intelligences parallel g as higher order factors at the top of the hierarchical structure of mental abilities. Gardner rejected the notion of even measuring his eight intelligences (Hunt, 2001), and four of them (linguistic, logical-mathematical, spatial, and perhaps musical) seem to reflect known abilities at the narrower Stratum 2 level (Carroll, 1993, p. 641). Profile differences among the Stratum 2 abilities can be important, as just noted, but no Stratum 2 ability will be strong unless its core ingredient, g, is strong too. Sternberg et al. (2000) purported to have evidence that an independent "practical intelligence" exists, is independent of g, and predicts "success" at least as well as g, but independent analyses of their evidence prove the claims to be false (Brody, in press-a, in press-b; L. S. Gottfredson, in press-a, in press-b).

Emotional intelligence has become a popular concept of late, but whether it reflects more than established traits of personality and intellect remains unclear. Recent evaluations also document confusion in its conceptualization, problems in scoring, low reliability, and disappointing predictive validity (e.g., Davies, Stankov, & Roberts, 1998; Petrides & Furnham, 2000; Roberts, Zeidner, & Matthews, 2001). The concept may reflect yet another assault on that vexing old problem—how to understand and measure "interpersonal" or "people" skills. I have long been frustrated by the lack of any classification of interpersonal abilities comparable to those for mental and physical competence but have begun to suspect that they represent the intersection of intellect and personality—the mentally adroit application of people—pleasing personality traits such as sociability and extraversion that motivate others to learn, buy, follow, and the like. There is no evidence, however, for a general emotional intelligence factor at any level of the three-stratum hierarchy, let alone alongside g at the top. Interpersonal and intrapersonal skills may be very important in certain activities and settings, but they do not seem to constitute broad cognitive abilities.

In short, despite intimations otherwise, the hierarchical model still captures our best knowledge about how human cognitive abilities relate to each other and affect performance in the real world.

Are Cognitive Abilities Measured Validly and Fairly?

Counseling psychologists have rightly been concerned that cognitive tests be fair and accurate. Fortunately, every national panel of diverse experts that has been convened in recent decades to examine the issue (Hartigan & Wigdor, 1988; Neisser et al., 1996; Wigdor & Garner, 1982; see also L. S. Gottfredson, 1997a) has reached the same conclusion. The major mental tests do indeed measure the cognitive abilities of native-born, English-speaking Americans valid-

ly and without cultural bias, regardless of race, ethnicity, gender, or social class. Both the individual and group differences in ability that cognitive tests chronicle reflect real variation in skills and abilities. This does not mean that tests cannot be biased or invalid—only that the major professionally developed tests have passed close scrutiny for the populations for which they are intended.

Any single test score is, of course, only a fallible and limited indicator of a person's competence. Cognitive tests nonetheless provide useful, objective information about people's capabilities and hence about the sorts of training, education, and occupations they will be competitive for and find most congenial. The two most important cautions in using cognitive test scores as indicators of aptitude (not achievement) are (a) if the test requires the use of language, test takers must be facile in the language used, and (b) the counselor must understand what the test in question actually measures (not look only to its title but to test reviews and evidence in the technical manual).

ABILITY REQUIREMENTS IN CAREERS AND CAREER DECISION MAKING

Research in the past few decades has shown that jobs' aptitude requirements are also highly structured.

What Is the Structure of Occupations' Ability Requirements?

Two sorts of data are especially useful: formal job analyses and studies predicting job performance. The former represent the ability requirements that job incumbents, supervisors, or trained job analysts have rated as most important based on their prior knowledge or new gathering of information on the particular jobs in question. As for the job performance studies, they provide evidence on whether differences in particular abilities among job incumbents or applicants actually correlate with current or future performance on the job. Both sorts of data have their limitations, but there is a wealth of both and they converge on the same overall pattern of ability demands. If abilities really are important in career development, then ability differences should also predict differences in people's educational and occupational careers. I will therefore summarize results from longitudinal career studies that assessed both interests and abilities.

Job performance research. I begin with the job performance studies because they can be simply summarized. The many hundreds of studies on the criterion-related validity of cognitive tests have themselves been extensively meta-analyzed (see L. S. Gottfredson, 2002a; Schmidt & Hunter, 1998, for summaries). Contrary to initial expectation, mental tests predict performance to some extent in all jobs, best in the most cognitively complex jobs, best when performance is

measured objectively and relates to the most core technical duties of a job, and almost always better than any other type of predictor. Moreover, specifically tailored cognitive test batteries do little better than a lone measure of g. Tests of spatial and clerical aptitudes add slightly to variance predicted but only in certain groups of occupations. Assessments of less cognitive traits (temperament, interests, and the like) also add little to the prediction of core job performance, although they do outpredict g when organizational "citizenship" (helpful to coworkers, professional demeanor, and such) is the performance criterion. Psychomotor abilities and length of experience in a job predict performance best where g predicts it least, namely, in the lowest level, most routine jobs. The advantages of relatively greater experience fade at higher average levels of experience, but the advantages of higher g do not.

Thus, when we look across the full landscape of occupations, two features of ability requirements stand out. First, the single Stratum 3 ability, g, is relevant to all jobs but especially so in the most cognitively demanding and prestigious ones. Second, differences in ability profiles at the Stratum 2 level also matter, but they are secondary in importance. Their effects are smaller and more narrowly targeted.

Job analyses. The foregoing personnel selection studies help employers determine which mental tests or test batteries will identify the most promising candidates for a particular job. The job analysis literature provides more guidance for career counseling, however, because it helps to illuminate which mixes and levels of abilities are required for minimally satisfactory performance in specific occupations of many types.

Early in my career, I analyzed every set of job analysis data I could locate that provided ratings for some large set of jobs in the U.S. economy (see especially L. S. Gottfredson, 1978, 1980, 1986a, 1997b). The data came from the *Dictionary of Occupational Titles* (*DOT*), *Guide for Occupational Exploration* (*GOE*), the Position Analysis Questionnaire, occupational reinforcers in the theory of work adjustment project, and other extant systems for describing work.

I had expected to find, for example, that the different Holland occupational interest categories represent functionally different work duties (working with people, things, etc.) and that different work functions would in turn require distinctly different profiles *of* ability. That was largely true but formed only a small part of the picture. Yes, aptitude demands are strongly related to the functional duties of a job. And yes, those demands are highly patterned. However, jobs' functional duties are distinguished primarily in terms of their cognitive complexity (e.g., independent problem solving and decision making vs. routine, repetitive, and highly supervised activities) and only secondarily in the content (dealing with people, things, numbers) to which one's brain or brawn is applied (L. S. Gottfredson, 1997b).

In other words, the most important distinction among jobs in their aptitude demands is for general intelligence level, which is a distinction that interest cat-

egories are not meant to capture. Ability profiles (e.g., spatial vs. verbal) become important only within the same general level of work (engineer vs. lawyer, lab technician vs. teacher). That is, one's standing on the Stratum 3 factor, g, is related to the job level one is likely to master, and one's profile of Stratum 2 abilities relates more to the suitability of different fields of work at any particular level. The job analysis data therefore paint the same two-dimensional portrait of work demands as do the job performance studies.

Both indicate, in fact, that the structure of abilities that jobs require parallels the structure of abilities that humans possess. The g factor is the key organizing element, and the narrower Stratum 2 factors provide only variations, albeit important ones, on the general theme. Perhaps this striking parallelism between the human and occupational structures should not be surprising in hindsight because the former will necessarily constrain how the latter develops over time (L. S. Gottfredson, 1985a). No occupation could survive long if it routinely required some combination of genetically conditioned abilities that a population seldom provides—say high spatial aptitude but no more than low intelligence.

Figure 2 helps to illustrate the findings on aptitude requirements and will be useful in later discussions of how to use them. It shows the 12 clusters of work that are formed on the basis of rated ability requirements for 66 groups of occupations in the *GOE*. Requirements were ascertained in both job analyses and criterion-related validity studies performed by the U.S. Department of Labor (as described in L. S. Gottfredson, 1986a). The two to four abilities that job analysts rated as most important, together with the minimum level they judged necessary for each, are listed in Figure 2. I have highlighted in boldface type only the cognitive requirements that have been independently validated by either personnel selection or career development research. Almost 90% of jobs in the 1970 U.S. economy are represented, the major omissions relating to managerial work (the *DOT* does not include supervisory positions) and new job titles since the 1970s, such as in computer and information technology.

The 12 occupational aptitude pattern clusters in Figure 2 create a familiar portrait of the world of work, in terms of both cluster content and the two dimensions along which they are organized. Requirements for general intelligence level (the Stratum 3 factor, g) create the vertical dimension, which coincides with occupational prestige, *DOT* ratings of complexity of work with data, and cognitive complexity of work (L. S. Gottfredson, 1980, 1986b, 1997b). Stratum 2 ability profiles create the horizontal dimension. The resulting four broad functional foci of work re-create a version of Holland's hexagon (in reverse order), with realistic and investigative collapsed under the heading of "Dealing With Physical Relations" and social and enterprising collapsed under the heading of "Dealing With Social and Economic Relations." The vertical and horizontal dimensions also reflect the two major concerns in career choice: Will my occupation give me high enough social standing? and Will I enjoy doing the work?

The lowest level, least complex occupations—Clusters P4-5 and B3—are almost all realistic and conventional. The importance of psychomotor abilities in

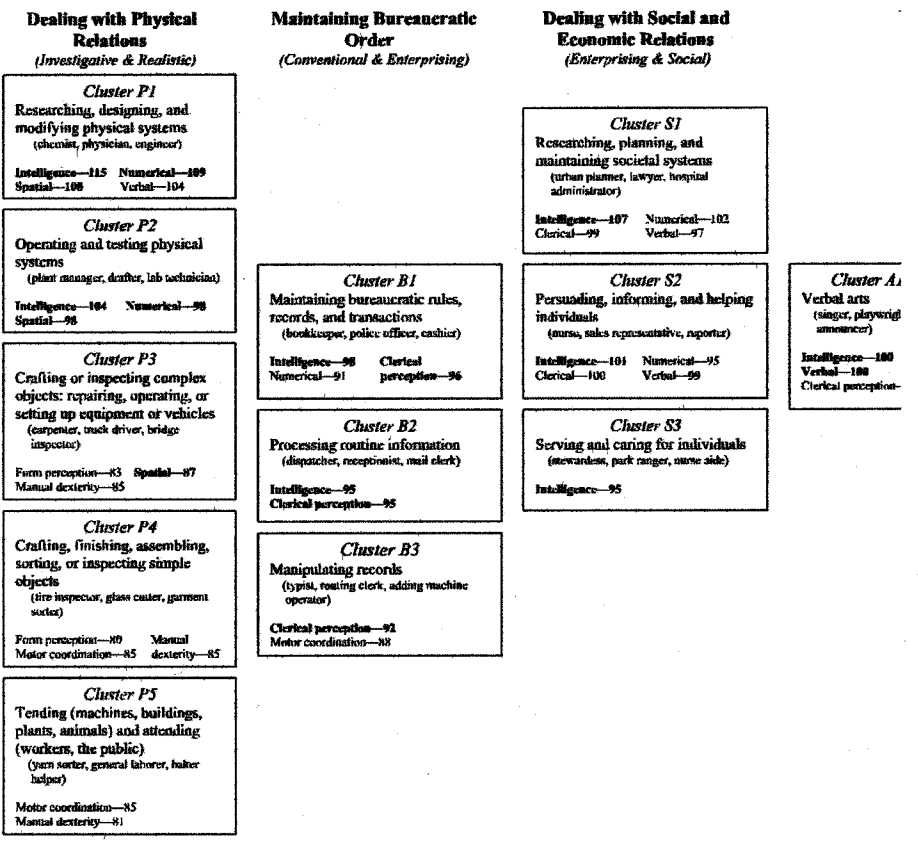

Figure 2. Occupational aptitude patterns map.

Source. Figure reprinted from L. S. Gottfredson (1986a) with permission from Academic Press.
Note. Ratings for cognitive aptitude requirements are in boldface when there is independent evidence for their validity.

these clusters but not in higher level clusters is consistent with the finding in job performance research that psychomotor abilities assume predictive importance when intelligence requirements are low. In addition, cognitive profiles are not relevant at this level of work because it emphasizes physical rather than mental capabilities. Cognitive profiles tend to be flat among low-IQ individuals and thus provide no opportunity for jobs to specialize cognitively. Although few in number, these clusters employ a large proportion of the labor force.

Cognitive profiles become more important at successively higher levels of work because occupations are more psychologically diverse at the higher levels. The low-average crafts (P3), clerical (B2), and social service (S3) clusters call, respectively, for mechanical-spatial, clerical, and no particular Stratum 2 aptitude. In terms of work duties, they require, respectively, complex dealings with

things, neither things nor people, and people. None requires complex dealings with data.

The seven clusters that require above average intelligence are yet more diverse. Several other kinds of ability profiles come into play. The same spatial/mechanical versus clerical contrast is found for physical (P1-2) versus bureaucratic (B1) clusters, with one artistic cluster (A2, which includes painting and sculpture) also requiring high spatial aptitude. Neither spatial nor clerical ability has been independently validated as important in any of the other clusters. Figure 2 thus overstates the breadth of importance of clerical speed, which serves in Figure 2 mostly to indicate "not spatial ability."

What these data show but the job performance studies do not is that mathematical reasoning (labeled "numerical" in Figure 2) is important in all the highest level physical clusters (P1-2), and verbal is important in the remaining artistic cluster (A1). This represents the well-known quantitative versus verbal contrast (for example, in SAT or Graduate Record Examination scores), and it coincides with the math-science versus humanities distinction in college majors. Both mathematical ability and verbal ability show up in the highest level social and economic clusters, but this result conflicts with better data on the issue (to be reviewed shortly). Their joint specification by job analysts reflects either a redundancy with the general intelligence rating or the heterogeneous nature of the social and economic category (it includes both social science and policy analysis, which require high math reasoning ability, and work in the humanities, which requires especially high verbal ability). Finally, were it to be measured, the Stratum 2 ability labeled broad auditory perception might show up as important for Cluster A1, which includes music.

Longitudinal career studies. But does career development actually flow along the channels carved out by job ability requirements? A longitudinal look at the educational and occupational careers of high school students, college students, and extraordinarily gifted 13-year-olds suggests that the answer to this question is "yes, to a surprising extent."

Austin and Hanisch (1990) used Project Talent data on interests and abilities in a large national sample of high school students to predict which of 12 occupational categories they worked in 11 years after graduation. Two discriminant functions predicted more than 80% of the variance in occupational category, the first "general ability" dimension being represented by high scores on the verbal and math tests. That first factor predicted occupational level held. The second discriminant function correlated most highly with mathematical (again), mechanical, and spatial abilities and predicted membership in physical sciences/engineering/mathematics versus office work. These two functions draw the same two major contrasts found in Figure 2: intelligence level in the vertical dimension and spatial versus not-spatial profiles in the horizontal.

Austin and Hanisch's (1990) two discriminant functions were less related to stated interests than to abilities. However, the first dimension reflected something

of a preference for "cultured" versus manual activities and the second a taste for hard science and technology rather than social service and office work (that is, for working vs. not working with things). The authors concluded that vocational psychologists have given too little weight to abilities in the career development process.

The importance of ability and interest profiles, relative to intelligence level, increases when research focuses just on college students (Achter, Lubinski, Benbow, & Eftekhari-Sanjani, 1999; Humphreys, Lubinski, & Yao, 1993; Humphreys & Yao, 2002; Lubinski, Webb, Morelock, & Benbow, 2001; Shea, Lubinski, & Benbow, 2001). College students represent primarily the top half of the intelligence distribution but are not similarly restricted in noncognitive attributes (Humphreys & Yao, 2002). Studies of college students essentially target educational preparation for the top seven clusters in Figure 2, all of which specify a minimum of average intelligence. These studies add important detail about the more psychologically diverse top layers of the occupational world.

First, Stratum 2 cognitive abilities—at least the ones usually measured (which at the college level excludes clerical)—do not distinguish all the major categories of work. Distinctive ability profiles are associated with college students' interests and enrollment in realistic, investigative, and artistic (humanities) majors but not for enrollment in social, enterprising, and conventional majors (Ackerman, 1996). Personality traits are more useful for distinguishing among the latter and from the first three. Specifically, conventional correlates with conscientiousness and social and enterprising with extraversion.

Second, three Stratum 2 abilities—mathematical reasoning, verbal, and spatial aptitude—are important for predicting the undergraduate and graduate degrees that students will pursue. There seem to be two general rules. One is that students who are high in verbal ability relative to mathematical reasoning ability (at any given level of intelligence) tend to pursue graduate degrees in law and the humanities and not in math or science. The other is that if students are high in quantitative skill, those who are also high in spatial ability will tend to pursue majors in engineering and the hard sciences, whereas the math talented who are not also spatially adept will pursue degrees in medicine or the biological and social sciences.

Third, these ability profiles tend to overlap interest profiles. For instance, students who are high in spatial ability tend to name the hard sciences as their favorite courses in high school and then pursue such majors in college and graduate school. That is, there is overlap between profiles of abilities and interests. Ackerman and Heggestad (1997) suggested, in fact, that there are four occupational "trait complexes"—science/math, clerical/conventional, social, and intellectual/cultural—based on their analyses of the relations among abilities, interests, and personality traits of college students. These four trait complexes replicate reasonably well the four types of higher level occupational clusters arrayed horizontally across Figure 2.