The Challenge and Promise of Cognitive Career Assessment

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Abstract

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 United States economy reveals that the two domains are structured in essentially the same way. I describe that common structure and how it can be used in assessing person-job match in terms of general ability *level* and ability *profile*. I also suggest 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.

The Challenge and Promise of Cognitive Career Assessment

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 path. 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 choice 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 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 neither 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 vs. Enterprising. You and I may differ dramatically, but neither is better. We may pursue different paths—science vs. 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 importantly, 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 last 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 paper 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., Gottfredson, 2002a; Lubinski & Dawis, 1992; Schmidt & Hunter, 1998), and publications for more general audiences (e.g., 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 over 400 factor analytic studies on the structure of human mental abilities. Figure 1 provides a much simplified version of it.

Insert Figure 1 About Here

At the lowest level, Stratum I, are the most specific abilities assessed by standardized mental tests, such as reading decoding (RD), memory span (MS), and associative memory (MA). These abilities not only are relatively narrow in scope, but also tend to be complex composites of the higher-order abilities, situational factors, and non-cognitive traits that might influence performance on a specific type of task in particular settings. At the next higher level of generality, Stratum II, are the well-known group factors of ability, including verbal aptitude, spatial aptitude, and 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 II 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 III factor called *g* (short for the *g*eneral mental ability factor). One Stratum II 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 III level. In contrast to Stratum I and II 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 II and III 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 II 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 II 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 four-year colleges since 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 II 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 II 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 non-cognitive domains means that cognitive assessments provide useful information that cannot be obtained from the non-cognitive inventories of personal traits. There are important points of overlap, as we shall see, but they are fairly localized.

<u>But aren't there multiple intelligences?</u>

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 rejects 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 II level (Carroll, 1993, p. 641). Profile differences among the Stratum II abilities can be important, as just noted, but no Stratum II ability will be strong unless its core ingredient—*g*—is strong too. Sternberg (Sternberg et al., 2000) purports 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 his evidence prove his claims to be false (Brody, in press a, in press b; 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 Gottfredson, 1997a) has reached the same conclusion. The major mental tests do indeed measure the cognitive abilities of native-born, English-speaking Americans validly 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 that (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 last 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-analysed (see 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 co-workers, 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 III 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 II 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 United States economy (see especially Gottfredson, 1978, 1980, 1986a, 1997b). The data came from the *Dictionary of Occupational Titles* (DOT), *Guide for Occupational Exploration* (GOE), Position Analysis Questionnaire (PAQ), occupational reinforcers in the Theory of Work Adjustment (TWA) 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 (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 categories 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 III factor, *g*, is related to the job level one is likely to master, and one's profile of Stratum II 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 II 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 (Gottfredson, 1985b). 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 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 bold-face 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 United States 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.

Insert Figure 2 About Here

The 12 Occupational Aptitude Pattern (OAP) 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 III factor, *g*) create the vertical dimension, which coincides with occupational prestige, DOT ratings of complexity of work with data, and cognitive complexity of work (Gottfredson, 1980, 1986b, 1997b). Stratum II ability profiles create the horizontal dimension. The resulting four broad functional foci of work recreate 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 these clusters, but not 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. While 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 II 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 vs. clerical contrast is found for “Physical” (P1-2) vs. “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 vs. verbal contrast (for example, in SAT or GRE scores), and it coincides with the math-science vs. humanities distinction in college majors. Both mathematical *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 II ability labeled broad auditory perception might show up as important for Cluster A1, which includes music.

<u>Longitudinal career studies.</u> 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 over 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 vs.

Office Work. These two functions draw the same two major contrasts found in Figure 2: intelligence level in the vertical dimension and spatial vs. 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" vs. 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 & Yao, 2002; Lubinski, Humphreys, & Yao, 1993; 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 non-cognitive 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 II 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 the among the latter and they from the first three. Specificially, Conventional correlates with conscientiousness and Social and Enterprising with extraversion.

Second, three Stratum II 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 (1996) suggest, 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.

Fourth, in some (unclear) proportion of cases, interest profile or other non-cognitive factors will override ability profile when there is a conflict. This is especially clear in groups of highly gifted students who possess *all* three key Stratum II abilities—verbal, mathematical, and spatial—in sufficient measure to qualify for *any* job requiring them. For instance, a study of extraordinarily gifted youngsters (all were above IQ 160) classified them according to whether their SAT scores in math and verbal at age 13 were about the same, tilted clearly toward math, or tilted toward verbal (Lubinski et al., 2001). About three-quarters of those with a math tilt later majored in math, medicine, or inorganic/organic science. Among those with a verbal tilt, about

70% of the women and 50% of the men majored in the social sciences or humanities. That leaves a substantial proportion in all cases—at least 1 in 4—who opted for undergraduate majors that did not use their peak ability.

Finally, the longitudinal career development data confirm that differences in intelligence shrink greatly in *relative* importance in high-IQ populations but still cannot be ignored. To illustrate, Humphreys and Yao (2002) found abilities were less useful than interests in predicting category of graduate degree. They also found, however, that graduate students in the different degree programs still differed unmistakably in average intelligence, with students in the physical sciences, biological sciences, engineering, and law having the highest average and those in education having the lowest (but still above average).

<u>Do cognitive abilities affect the decision-making process itself?</u>

Theories of career development tend to be of two types, those that emphasize the person-job match process (such as "person-environment-correspondence" theory; Dawis, 2002) and those that stress the process rather than product of decision making (such as the "cognitive information processing approach to career problem solving and decision making;" Peterson, Sampson, Lenz, & Reardon, 2002). In this paper I have emphasized the role of abilities in person-job match. It is worth noting, however, that cognitive abilities, and *g* in particular, are highly relevant to theories of the second type. Any theory that uses the language of learning, information gathering, information processing, abstract thinking, decision making, reasoning, and problem solving is implicitly focusing on general intelligence. Those are the very skills, the higher-order thinking skills, by which *g* manifests itself in daily life. Such skills affect how quickly children learn about themselves and the world of work (Gottfredson, 1981, 2002b), and they can be expected to influence the quality of decision making on all matters in life, careers included. This means that some counselees may need more cognitive support, less complicated materials, or more concrete interventions during the counseling process.

Using Cognitive Abilities in Career Counseling

The facts on cognitive abilities are important, but how can career psychology best use them? There are four major challenges. I will argue that they are best met by integrating cognitive assessment seamlessly into a broader process of exploring and evaluating career options. That process, in turn, should be aimed at increasing career opportunities, partly by helping counselees increase their competitiveness for the occupations they prefer.

How can cognitive assessment be used to expand career opportunities?

Effective career exploration has to address the obstacles as well as possibilities that counselees face in career development. No option is a good one unless it is truly feasible—or can be made so. Non-competitive ability levels for a preferred occupation are clearly an obstacle. Likewise, no good opportunity will be realized if it lies unseen and fallow. Many young people unnecessary circumscribe their occupational aspirations even before they reach adolescence, sometimes because they understate their abilities or mistakenly believe that certain classes of work are not available or appropriate for persons like themselves (Gottfredson, 2002b).

"Reality-based career exploration" (Gottfredson, 1985a, 1986b, 1996a) can be used to reverse such premature closure and encourage a closer look at what is actually required to implement preferred options successfully. The process involves three kinds of opportunity-enhancing confrontations with reality. The first is to confront individuals with the big picture of the world of work. The aim is to have them determine whether they wish to revisit occupational categories that they may have unthinkingly and inappropriately ruled out of consideration at an earlier age. This confrontation with reality necessitates providing them an organizing framework, a cognitive map of the occupational world, by which they can identify the most and least attractive segments of that world in light of their interests and abilities.

The second opportunity-enhancing confrontation with reality comes after they have identified a list of "best bets" to explore in more detail. One aim at this stage is for individuals to assess their competitiveness for the options on their short list. This requires explicit consideration of their Stratum II and III abilities, because they affect one's chances of passing the necessary education, training, and certification hurdles, at least with a reasonable expenditure of time and effort.

Non-competitiveness in broad abilities for some preferred sphere of work clearly limits opportunity. But competitiveness can usually be *enhanced*, sometimes markedly so. Exploring ways to enhance one's competitiveness promotes a realistic attitude while simultaneously increasing opportunities—and activity—for reducing constraints. Already-mature individuals cannot expect to increase their broad abilities, but there may be many other ways they can increase their competitiveness. For instance, they can emphasize any strong non-cognitive traits (engaging personality, conscientiousness and integrity) or develop relevant specific knowledges, skills, and abilities (learn another computer program, find a tutor or mentor, prepare more fully for interviews). These other personal attributes cannot substitute for essential cognitive abilities that are lacking, but they may make the difference when broad abilities are at least near the margin. Encouraging individuals to increase their competitiveness for favored choices forces them to scrutinize feasibility more than they might otherwise. It encourages self-development. Forewarned, people can become forearmed.

The third opportunity-enhancing confrontation with reality is for counselees to develop clear "back-up" options, especially when their more ambitious plans seem unrealistic. Risky choices need not be explicitly discouraged if counselees fully recognize and prepare for the risks.

Some individuals will succeed in their ambitions against all odds, and the others will be prepared with good alternatives.

Which cognitive abilities should be considered?

The broad Stratum II and III abilities are most important, especially when identifying the general occupational categories that would be "good bets." Stratum III intelligence level (g) and Stratum II ability profiles represent the two major dimensions of jobs' ability requirements, as discussed earlier, and also the two major concerns that people have in vocational choice (prestige and field of work). They thus affect both one's satisfactoriness and satisfaction as a worker (Dawis, 2002). At a minimum, verbal ability, mathematical reasoning, spatial-mechanical ability, and clerical speed/perception (they come by various names) define aptitude profiles that are relevant to sizeable groups of occupations.

But why limit the big portrait to Stratum II and III abilities? Common sense says that the Stratum I and yet more specific skills and abilities matter too. While that is true, they do not belong in the big picture. They constitute only the shifting detail in the larger scheme, and they can be considered after a smaller subset of viable alternatives has been identified for intensive examination. More importantly, however, the broader abilities are more stable and thus constitute the more enduring advantages or disadvantages in career choice. Much research has shown that they predict, rather than result from, achievement in school and work. The broad abilities must therefore be *matched* in the career development process, whereas the specific abilities can more often be *trained*. The latter's greater trainability is precisely why specific abilities become important as exploration narrows to an in-depth look at the requirements, rewards, and availability of a short list of "best bets." That is the point at which individuals can determine how to acquire or enhance the specific skills required for the particular occupations they imagine pursuing in earnest.

<u>How should occupations be classified for purposes of assessing degree of person-job match?</u>

If career counseling is to incorporate cognitive abilities, so too must its occupational classifications. Currently, they do not. Ability *profile* is at best included only implicitly and indirectly, and general ability *level* is absent altogether (often by design) or confounded with field of work. Government classifications, such as the various census occupational schemes, are generally some unclear mix of field and level. Holland (1997) has taken a step to include level in his counseling materials by providing GED level for all occupational titles in the *Dictionary of Holland Occupational Codes* (Gottfredson & Holland, 1996). GED level, like prestige and the DOT's "complexity of dealings with data," is highly correlated with general intelligence requirements. However, Holland's hexagonal model does not itself incorporate level, nor does the ACT interest inventory's World-of-Work Map. In both systems, occupational level and ability requirements are just auxiliary detail. The new O*NET occupational information system (http://online.onetcenter.org), which is meant to replace the *Dictionary of Occupational Titles*, incorporates various classificatory schemes (including Holland's) but provides no global orientation. Because it focuses on detail only, it is most useful at later rather than early stages of exploration.

To be most useful, a classification has to be comprehensive, valid, and simple to use and understand (Gottfredson, 1986a). It must be comprehensive in the sense of including the entire range of jobs in an economy, all the key dimensions of people and jobs that affect person-job match, and detailed information on the requisites, rewards, and availability of particular occupations. That means that ability requirements should be one element but not the sole focus of any aptitude-based occupational classification. To be valid, the classification should include abilities that are well researched and for which there are valid measures, describe job aptitude requirements that have been empirically validated, and include the most important of them. Yet the classification must also be simple. This requires at least two things: an organizing framework and direct links between that framework and bodies of more detailed data. The organizing framework is the gateway into deeper levels of the classification. It is a small set of broad occupational categories (say, 6-12) arranged in a compact and transparently meaningful "cognitive map" of occupations. These broad categories should, in turn, provide direct links to repositories of information about the many specific occupations within those categories, because these paths allow exploration to move easily from the big picture to narrower targets of interest.

Classifications based on Holland's typology of vocational interests could perhaps be expanded to include ability requirements. That would require distinguishing among ability/complexity levels within each of the six interest types and also among ability profiles at any particular level of job complexity. Another option would be a simplified version of the Occupational Aptitude Patterns Map in Figure 2. But whatever the scheme, both horizontal and vertical distinctions are required. The vertical intelligence dimension can be labeled more benignly as job complexity or academic ability rather than prestige or intelligence.

How should the broad cognitive abilities be assessed?

I see no need to automatically administer tests of cognitive abilities. The broad Stratum II and III abilities are utilized and tested so frequently during the high school and college years that students have generally accumulated a large set of rough indicators for them. Grade point average, class rank, and SAT and GRE scores provide rough guides to general ability (although the meaning of grades and class rank depends on the high school attended). Quantitative vs. verbal profiles can be discerned by comparing grades and test scores in math and science to those in English and social studies, and so on. Schools do not seem to provide surrogate measures for spatial or mechanical ability, however.

Self-estimates of intelligence are not accurate enough to be useful. Students may be prone to under- or overestimate their ability when they come from relatively homogeneous populations (the big fish in a small pond problem). Moreover, women tend to underestimate their intelligence level (Furnham, 2001). The most objective, universal yardsticks of general ability are therefore to be preferred, such as the total score (or a derived *g*) on standardized tests like the SAT or Differential Aptitude Tests (DAT).

Ability profiles are *intra*individual comparisons of abilities, however, so self-estimates may be more appropriate for assessing whether an individual has a bent toward one Stratum II ability or another. Test scores, course grades, and personal experience will generally have made college-bound students aware of whether they have a quantitative or verbal bent, and non-college-bound students aware of whether they are good working with mechanical objects rather than clerical detail. Where needed, general aptitude test batteries such as the Differential Aptitude Tests (DAT), Armed Services Vocational Aptitude Battery (ASVAB), and General Aptitude Test Battery (GATB) can administered to confirm either general level or shape of an individual's aptitude profile, especially when occupations that require mechanical or spatial ability are being considered. Individuals can also gain more evidence by obtaining relevant experience.

Assessments of aptitudes, by whatever means, need not be highly precise for most purposes. All that is needed during the early broad exploration phase is a rough indication of how competitive a person would be for the occupations in a cluster, which themselves are probably a heterogeneous lot. Would the individual be extremely competitive, in the middle of the pack, or fighting an uphill battle compared to the typical applicant for those occupations?

There must also be some way to map an individual's abilities onto occupational ability requirements to see how well they match. For instance, it is not enough simply to know that spatial ability is "important," but also the *level* needed to be competitive. That is, we need to develop a calculus for matching the levels of ability people possess with the levels of ability occupations require. There is no such calculus yet. Much information exists, however, on the IQ scores of applicants and incumbents in different occupations (e.g., see Gottfredson, 1997, pp. 88-89), so a person's general intellectual competitiveness for them can be estimated by looking at their percentile standing on any highly *g*-loaded test (where the norms are for the general population). It may also be sufficient to make only four or five distinctions in requirements for academic aptitude, ranging from very high, high, average, to "non-academic", or, alternatively, from "usually a graduate or professional degree (or equivalent)" to "usually no high school diploma necessary." Job complexity and educational degree required are hardly synonymous, but Figure 2 suggests that they are probably correlated closely enough to be workable in this context.

It is less clear how one might quantitatively estimate competitiveness in terms of ability *profile*, especially when no surrogates for mechanical or spatial ability are available, but such estimates are probably less critical. Perhaps a simple yes-no judgment is all that is required for assessing profile match in many cases. Because interest and ability profiles overlap somewhat, the former can sometimes provide additional evidence for the latter.

Prospect

Cognitive abilities are at least as important as vocational interests in career development. Reviving and wisely implementing cognitive career assessment therefore holds much promise for counseling. Research in recent decades has provided new insight into the structure of human abilities and the aptitude requirements of occupations. Both structures are simpler and more parallel than once assumed, which greatly aids their use in counseling.

The challenges in cognitive career assessment relate to remaining gaps in knowledge and in how to integrate cognitive assessment most effectively into career counseling. Two major knowledge gaps are that the distribution, stability, and practical importance of Stratum II ability profiles is not nearly as well understood as it is for Stratum III *g* level, and that we need more data to develop a good calculus for assessing degree of match between abilities possessed and abilities required, especially at the Stratum II level. Such data will guide decisions about which occupational classifications and person-job match procedures are best. Major questions in how to integrate cognitive assessment involve determining when formal rather than informal cognitive is required and where in the sequence of career exploration and decision making, and in what manner, a person' cognitive abilities should be reviewed.

Different populations may pose somewhat different challenges in implementing cognitive career assessment, but all would profit from it. All persons can use this knowledge of self and work to increase their career options.

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Figure Captions

Figure 1. Hierarchical Structure of Cognitive Abilities

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 II factors, respectively, crystallized intelligence (2C), broad visual perception (2V), and general memory and learning (2Y). The Stratum I 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 (1993, p. 626) for the five other Stratum II factors in his summary model, as well as for the other Stratum I factors that are correlated with the Stratum II factors shown here in Figure 1. Figure reprinted from Gottfredson (in press c) with permission from Allyn & Bacon.

Figure 2. Occupational Aptitude Patterns (OAP) Map

Ratings for cognitive aptitude requirements are in bold-face when there is independent evidence for their validity. Figure reprinted from Gottfredson (1986a) with permission from Academic Press.