PeopleHawk

THE SCIENCE BEHIND PEOPLEHAWK:

The best way to predict the future **is to create it**

A single factor for intelligence, called g, really can be measured and it does predict success

The Intelligence Debate

The study of human intelligence has provoked more intense scrutiny than any other subject in psychology. Research into how and why people differ in their overall mental ability has long been subject to political and social agendas that obscure or distort even the most well-established scientific findings. Journalists have also played a role by offering a view of intelligence research that is the polar opposite of what most intelligence experts believe. Little wonder then that public. understanding of intelligence lags far behind public concern about it. Cognitive scientists discussing their work in the public arena can feel as though they are addressing a parallel universe.

The issue of intelligence and intelligence testing focuses on whether it is either useful or indeed valid to assess people according to a single major dimension of cognitive competence. Does a general mental ability called 'intelligence' exist and is it of practical importance in our lives? The answer, based on decades of intelligence research, is a resounding 'yes'. Irrespective of their form or content, tests of mental skills indicate the existence of an overarching factor that permeates every aspect of cognition. Furthermore, this factor seems to play a considerable role in determining the practical quality of a person's life.

Early studies of intelligence revealed that all tests of mental ability ranked individuals in more or less the same way. Although mental tests are often designed to measure specific areas of cognition, such as mental flexibility, logical reasoning and working memory, people who perform well on one type of test tend to do well on the others. Similarly, people who do less well generally do so across the board. This overlap suggests that all such tests measure some global element of intellectual ability as well as specific cognitive skills. This global or 'general' factor is scientifically abbreviated as '*g*'.

Isolating g

For some time psychologists have tried to isolate that general factor, *g*, from the other aspects of cognitive ability gauged in mental tests using a statistical technique called factor analysis. Factor analysis was introduced in the early twentieth century by British psychologist Charles Spearman. It determines the minimum number of underlying dimensions necessary to explain a pattern of correlations among measurements. A general factor that permeates all tests is not a necessary outcome of factor analysis. In fact, no general factor has been found in the analysis of personality tests, rather the method usually uncovers at least five dimensions (Extraversion, Conscientiousness, Openness, Agreeableness and Emotional Stability), each relating to different subsets of tests.

However, as Spearman noted, analyses of mental ability tests do reveal a general factor and this has since been confirmed by leading psychologists, such as Arthur R. Jensen of the University of California at Berkeley and John B. Carroll of the University of North Carolina at Chapel Hill. As a result, most intelligence experts now use *g* as the working definition of intelligence.

g and IQ

The general factor or *g* largely explains why different people perform differently across a range of mental tests. This is true regardless of:

(i) the ability being tested
(ii) the test's content (whether words, numbers or figures)
(iii) how the test is administered (written/oral, individual/group).

While tests of specific mental abilities do measure those abilities, they all reflect *g* to varying degrees as well. This means that the *g* factor can be extracted from scores on any diverse tranche of tests. On the other hand, because every mental test is skewed by the effects of specific mental skills, no single test measures only *g*. Even IQ scores - which usually combine about a dozen subtests of specific cognitive skills - contain some 'contaminants' that reflect those narrower skills. These impurities usually make no practical difference but intelligence researchers can statistically isolate the *g* component of IQ, if required.

g as the active ingredient

The ability to isolate *g* has revolutionised research on general intelligence. It has allowed investigators to show that the predictive value of mental tests is due almost entirely to this global factor, rather than the more specific aptitudes measured by intelligence tests. In addition to quantifying individual differences, tests of mental abilities have also thrown light on the meaning of intelligence in everyday life.

Some tests and test items correlate better with g than others. Here, the catalyst for *g* seems to be complexity. As tasks become more complex they require more mental dexterity, and this manipulation of information – identifying trends and differences, making inferences, understanding new concepts, etc. – is intelligence in action. In other words, intelligence is the ability to deal with cognitive complexity.

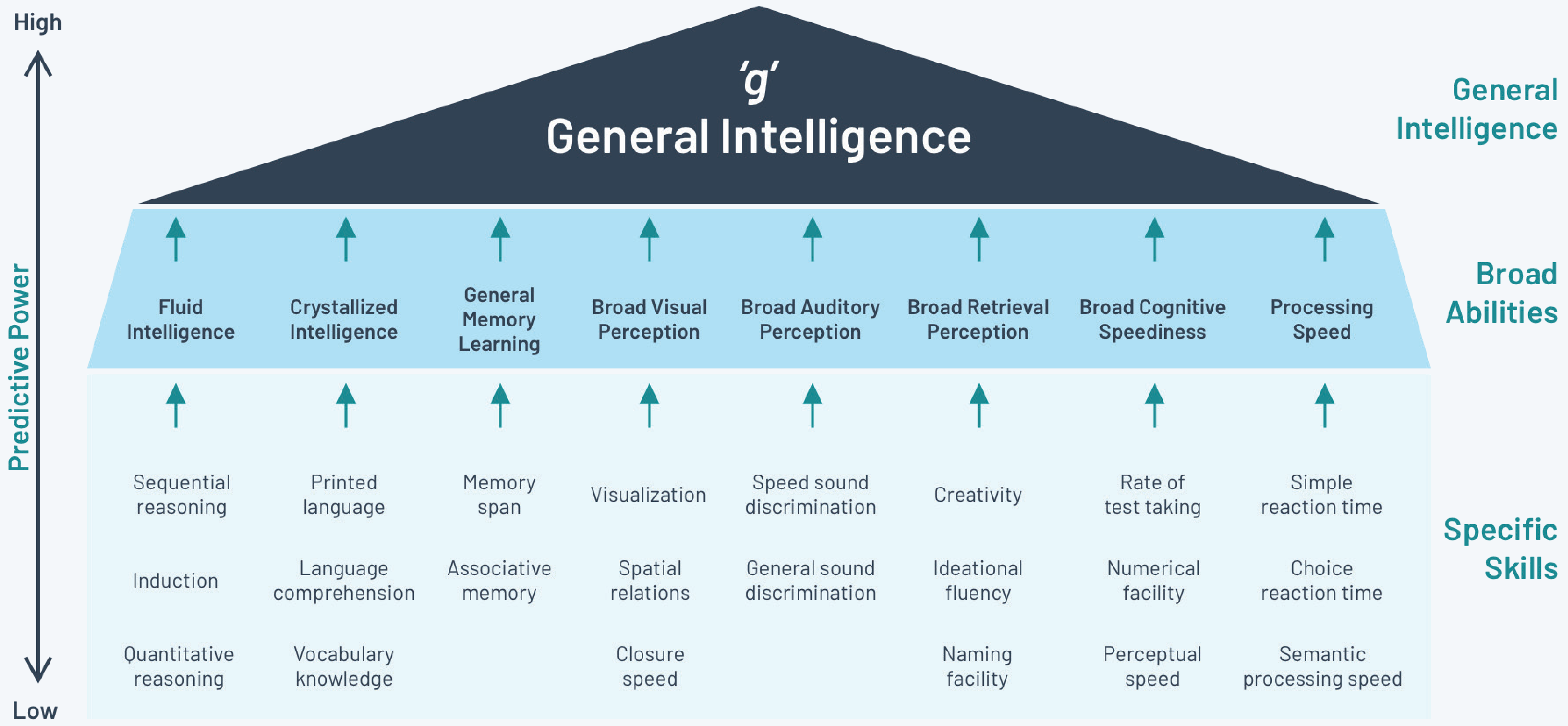
This description aligns closely with lay perceptions of intelligence. The *g* factor is especially important in behaviours that people usually associate with 'being clever': reasoning, problem solving, abstract thinking, quick learning. In addition, whereas *g* describes mental aptitude rather than accumulated knowledge, the amount that a person knows tends to correspond with their *g* level, probably because their accumulated knowledge represents an ability to learn and understand new information. The *g* factor is also the one attribute that best distinguishes persons considered gifted.

The hierarchy of intelligence

Several decades of factor-analytic research on mental tests have confirmed a hierarchical model of mental abilities. The evidence for this is best summarised in Carroll's 1993 book, *Human Cognitive Abilities*. Carroll puts *g* at the apex in this model and arranges more specific aptitudes at successively lower levels. Just below *g* are the group factors, or Broad Abilities, which include verbal ability, mathematical reasoning, spatial visualization and memory. Below these are the Specific Skills – these are more dependent on knowledge and/or experience, such as principles and practices acquired through a job or profession. Refer to Figure 1 below.

Some researchers describe these sets of narrow capabilities and achievements as 'multiple intelligences', so other forms of intelligence have also been proposed, including emotional intelligence and practical intelligence. They probably reflect a merger of intellect and personality or intellect and informal experience. Practical intelligence – being 'savvy' for example – seems to consist of the general knowledge and know-how that comes from the school of hard knocks. In contrast, general intelligence is not a form of achievement, whether local or renowned. Instead, the *g* factor regulates the rate of learning: it greatly affects the rate of return in knowledge to instruction and experience but cannot substitute for either.

Figure 1 - Hierarchy of Intelligence.



Source: Carroll, 1993

The role of *g* on education

If we take the position that intelligence reveals itself as the ability to deal with the complex situations that arise in everyday life, then it becomes apparent why it has such functional and/or practical importance. Children, for example, become exposed to complex tasks once they begin school, so they must learn, solve problems and think abstractly. On this basis it is not surprising that IQ is a reasonable predictor of differences in educational achievement.

It is worth considering that when scores on both IQ and standardised achievement tests in different subjects are averaged over several years, the two averages correlate as highly as different IQ tests from the same individual do. Investigations into why high-ability students grasp material much faster than their low-ability peers have helped to quantify this discrepancy. For example, a 1969 study done for the U.S. Army by the Human Resources Research Office found that enlistees in the bottom fifth of the ability distribution required two to six times more teaching trials and prompts than their higher-ability peers to attain minimal proficiency in many basic military tasks.

Similarly, the ratio of learning rates between 'fast' and 'slow' school students is typically five to one. Many IQ tests give the impression that *g* is only a narrow academic ability. But general mental ability also predicts job performance, and in more complex jobs it does so better than any other single personal trait, including education and experience.

The influence of *g* on training

The measurement of *g* plays a vital role in the predictive value of mental tests in the work arena and that value rises with more complex and prestigious jobs. More than fifty years of military and civilian research has merged to show that occupational opportunity lies along the IQ continuum.

Few occupations are beyond the reach mentally of individuals in the top 5 percent of the adult IQ distribution (above IQ 125). Professional and executive-level work may be beyond those of average IQ (between 90 and 110) but they are easily trained for the bulk of jobs in the economy. In contrast, adults in the bottom 5 percent of the IQ distribution (below 75) are very difficult to train and are not competitive for any occupation on the basis of ability.

During the Second World War, the training of low-IQ military recruits to the U.S. Army caused serious problems, which led Congress to ban enlistment from the lowest 10 percent (below 80) of the population. Current military enlistment standards exclude any individual whose IQ is below about 85 and no civilian occupation in modern economies routinely recruits its workers from that range.

In the 1980s the U.S. Army conducted Project A, a seven-year study to improve its recruitment and training process. The project found a strong correlation between general mental ability and both technical proficiency and soldiering in the nine specialties, including infantry, military police and medical specialist. This pattern is borne out by research in the civilian sector. Furthermore, although the addition of personality traits such as conscientiousness can help to refine the prediction of job performance, the inclusion of specific mental aptitudes such as verbal fluency or mathematical skill rarely does.

Efforts to model job performance have helped to clarify the role of *g* in both training and job proficiency. They indicate that *g* strongly predicts success in training and acquiring job knowledge, both of which strongly predict task proficiency (Borman, White, Pulakos, & Oppler, 1991; Borman, Hanson, Oppler, Pulakos, & White, 1993; Borman, White, & Dorsey, 1995; Hunter, 1983; Ree, Carretta, & Teachout, 1995; Schmidt, Hunter, & Outerbridge , 1986).

g on the job

As in education, the role of *g* in job performance is affected by complexity. As jobs become more complex, higher *g* levels are advantageous, while lower *g* levels are a handicap. Similarly, everyday tasks and environments also differ significantly in their cognitive complexity. The degree to which a person's *g* level influences their daily life depends on how much challenge and change they face in everyday tasks and from their environment, as well as the amount of learning, judgment and decision making they are required to make. Even small differences in *g* among people can create large, cumulative impacts in performance and success.

It should be noted that reasoning, problem solving, decision making and other higher order thinking skills are facilitated by a highly general information-processing capacity. Research in job analysis and personnel selection show that *g* is useful well beyond academic pursuits. Intelligence turns out to very important in predicting job performance and the research allows strong inferences about its causal importance.

Illustrative correlational data

Civil rights law and regulation have caused many employers to examine the validity of their selection procedures (Sharf, 1988). They have also prompted a search for less *g*-loaded selection procedures (i.e. less related to intelligence) in order to reduce any disparate impact of selection procedure on minority hiring and minimise employers' exposure to employment discrimination lawsuits (Gottfredson & Sharf, 1988).

This means there is now considerable evidence concerning the predictive validity of various mental aptitudes, personality traits and physical capabilities (e.g., see Gottfredson, 1986b; J. Hogan, 1991; R. Hogan, 1991; Landy, Shankster, & Kohler, 1994; Lubinski & Dawis, 1992; Schmidt, Ones, & Hunter, 1992; Stokes, Mumford, & Owens, 1994). Many of these data have been meta-analysed.

Predictive powers of *g*

The first important point to note is that personnel psychologists now accept that *g* helps to predict performance in most if not all jobs (Hartigan & Wigdor, 1989). However, there is still some dispute over the size of these predictive validities. Estimates of the average validity of *g* across all jobs in the economy generally range between .3 and .5 (on a scale from 0 to 1 .0, a correlation of 1.0 meaning the test can predict job performance with complete accuracy), depending on how validities are corrected for unreliability in the criterion and restriction in range on the predictor (Hartigan & Wigdor, 1989). These estimates are based primarily on studies that used supervisor ratings of job performance. Average validities are even higher when performance is measured objectively. For example, Hunter (1986) reported that correlations of *g*-loaded tests with work sample ("hands-on") performance versus supervisor ratings were .75 versus .47 in a sample of civilian jobs and .53 versus .24 for a range of military jobs. Validities vary widely across different kinds of jobs, from a low of about .2 to a high of .8.

It is important to note that predictive validities vary systematically according to the overall complexity of the work involved. Hunter (1983, 1986) demonstrated this clearly with U.S. Employment Service General Aptitude Test Battery (GATB) validity data for 515 occupations (see also Gutenberg, Arvey, Osburn, & Jeanneret, 1983).

g = single, most powerful predictor of overall job performance

In short, *g* is the most powerful single predictor of overall job performance. First, no other measured trait, apart from conscientiousness (Landy et al., 1994, pp. 271, 273), is so widely used across all jobs in the economy. Other personality traits and aptitudes, such as extraversion or spatial aptitude, may seem more important than *g*, but only across a more limited range of jobs (e.g., Barrick & Mount, 1991; Gottfredson, 1986a). Second, no other single predictor measured to date (specific aptitude, personality, education, experience) seems to have such consistently high predictive validities for job performance.

The clearest exceptions to the predictive superiority of *g* prove its relative importance. Psychomotor aptitudes sometimes have higher predictive validities than *g*, but only in low-level work (validities for *g* and psychomotor aptitudes vary inversely with each other; Gottfredson, 1986a; Hunter & Hunter, 1984). Validities for experience can also sometimes rival those for *g*, but, once again, they fall as complexity increases (McDaniel, Schmidt, & Hunter, 1988). In addition, unlike those for *g*, they fall as groups gain more job experience (Schmidt, Hunter, Outerbridge, & Goff, 1988). In more experienced groups of workers the advantages of superior experience fade, but those of superior *g* do not. In short, there is no rival to *g* in predicting performance in complex jobs. Average validity coefficients for educational level (0.0 to .2) are inconsequential relative to those for *g* (Hunter & Hunter, 1984).

Third, *g* generally predicts training and job performance about as well as many other predictors and, in any case, "carries the freight of prediction" in those batteries (Jensen, 1980, pp. 347-349; Ree, Earles, & Teachout, 1994; Thorndike, 1986). Less cognitive traits such as personality and interests may better predict the less central dimensions of job performance, but this exception once again proves the relative importance of *g*.

Criterion-referenced data

The specific meaning of higher versus lower intelligence on the job, and in everyday life is best illustrated by linking intelligence levels to specific job proficiency levels, in other words, by providing criterion-referenced data. For example, what exactly can workers of different ability levels do, and how quickly and accurately can they learn to do it? Unfortunately, little information on this subject has been published, but the manuals and reports for civilian and military employment testing programmes provide a good start in piecing together criterion-related interpretations.

All such programmes provide measures of *g*, although they are not always labelled as such. Take, for example the Wonderlic Personnel Test (WPT), which is a 50-item intelligence test that many employers have used to screen job applicants. Its validity and reliability for this purpose compare favourably with other adult intelligence tests. The manual for the Wonderlic provides the most comprehensive, up-to-date and publicly available data on the g demands across a wide variety of civilian jobs.

Higher levels of *g* are required up the occupational ladder

Figure 2 presents data from WPT. It illustrates the broad pattern documented by the big military and civilian testing programs during the first half of last century (see Matarazzo, 1972, chap. 7, for a summary). The first observation is that there is much intelligence variation within all occupations and much overlap among them. Occupations attract and accommodate individuals from a wide range of intelligence levels. As Figure 2 shows, the middle 50% of applicants to a job generally covers a range of 7.5 to 10 points on the WPT scale.

Applicants to particular jobs tend to be more homogeneous than the general working population: specifically, the median Standard Deviation of WPT scores of applicants to the specific occupations shown in Figure 2 (6.3 WPT points) is 83% of that for the entire working population (7.6; Wonderlic Personnel Test, 1992, pp. 25, 27; but see also Sackett and Ostgaard, 1994, p. 682). Job incumbents, in turn, are more homogeneous than applicants: the Standard Deviation of job incumbents on ability tests is .6 to .7 of that for applicants (Hunter, Schmidt, & Judiesch, 1990), but they still range widely in ability.

Figure 2

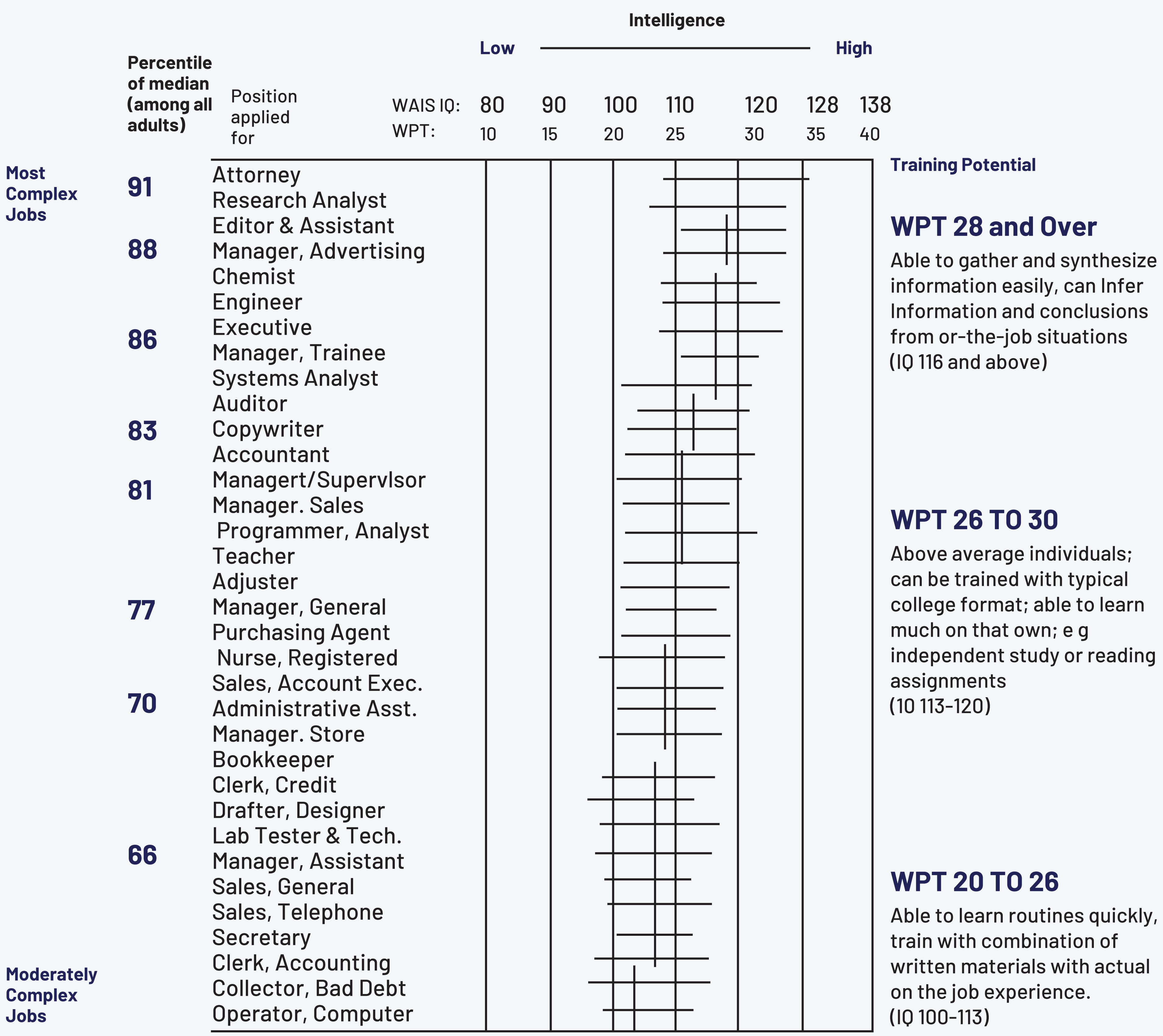
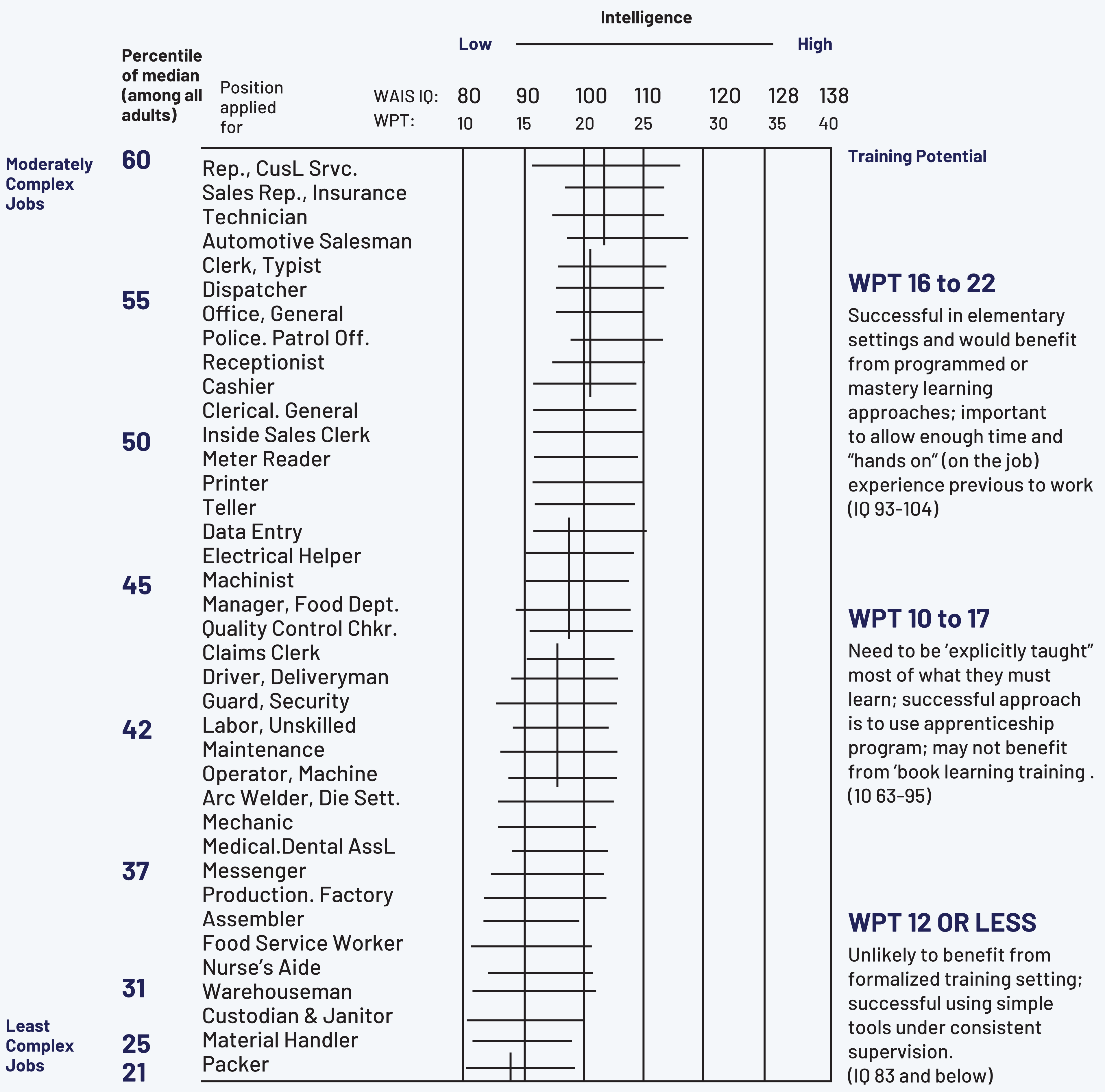


Figure 2: Wonderlic Personnel Test (WPT) scores by position applied for (1992). The bold horizontal line shows the range between the 25th and 75th percentlies. The bold crossmark shows the 50th percentile (median) of applicants to that job. *Source:* Wonderlic (1992: 20, 26, 27).



The second important point is that there are striking differences in the intelligence ranges from which occupations tend to draw the bulk of their workers. More specifically, there appear to be minimum intelligence thresholds that rise steadily with job level.

Higher *g* reflects higher trainability.

As indicated above, the threshold below which individuals risk being unemployable in modern economies seems to be WPT 7.5 to 10. This seeming lower boundary of today's occupational order becomes more understandable when considering the trainability of individuals at different intelligence levels, as indicated in the right portion of Figure 2. This suggests that individuals below WPT 10 to 12 are unlikely to benefit much from training in any formalised setting and will later need constant supervision using even simple tools.

Even up to Wonderlic score 17, workers tend to need explicit teaching of most of what they need to know and they do not benefit much from 'book learning' training. Better training technology might improve success rates for all groups, but it would not equalise them. As a result, employers seek individuals with a greater capacity to learn independently and to work without close supervision, especially for more complex jobs. Indeed, the job descriptions of managerial, executive, and professional workers themselves suggest that high-IQ, self-trainable individuals are essential: that is, individuals who are better able to "learn much on their own" and from the "typical university format" (WPT 26-30) and to "gather and synthesise information" and "infer information and conclusions from on-the-job situations" (WPT 28 and above).

This roughly 30% of the working population above WPT 25 (25% of the total adult population) would also be essential for training and supervising even the next lower third of the working population, which is 'able to learn routines quickly' and with a 'combination of written materials and actual job experience' (WPT 20-26).

Mother nature knows best

There are many kinds of talent, many kinds of mental ability and many other aspects of personality and character that influence a person's chances of success. But intelligence, as measured by a battery of cognitive tests, is the single most effective predictor known of individual performance at school and on the job. Most intelligence researchers take these findings for granted. Yet in the press and in public debate, the facts are typically dismissed, downplayed or ignored. This misrepresentation reflects a clash between a deeply felt ideal and a stubborn reality.

The ideal, implicit in many popular critiques of intelligence research, is that all people are born equally able. The reality is that Mother Nature is no egalitarian. People are in fact unequal in intellectual potential - and they are born that way, just as they are born with different potentials for height, artistic flair, athletic prowess and other traits. Although subsequent experience shapes this potential, no amount of social engineering can make individuals with widely divergent mental aptitudes into intellectual equals.

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