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CHAPTER 1

Intelligence as Potentiality and Actuality

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In two seminal articles, David Wechsler emphasized the importance of non-ability determinants of adult intelligence, and called for a more inclusive consideration of traits beyond that which is assessed by traditional intelligence quotient (IQ)–type measures. Wechsler's main point was that in order to predict an individual's ability to "understand the world about him and his resourcefulness to cope with its challenges" (Wechsler, 1950, 1975, p. 139), one needs to have a much broader understanding of the individual beyond a single IQ score. A second issue with modern intelligence assessment is that at various times, an IQ score has been seen to reflect an individual's 'capacity' for intellectual competence, rather than a snapshot of the individual's performance from which inferences can be made, such as the likelihood that a child will succeed academically (Anastasi, 1983). In the current chapter, an effort will be made to explicitly distinguish between the concept of intelligence as a 'potentiality' from intelligence as an 'actuality,' and inclusion of non-ability constructs, especially with respect to the abilities of older adolescents and adults.

Fundamental Issues about Intelligence

Ever since Binet and Simon published the first modern scales to measure child intelligence, the fundamental purpose of intelligence assessment has been for *prediction* – whether it be performance in the classroom, laboratory, workplace, or in success at other life tasks. Although there have been many basic research efforts that purport to focus on finding basic properties of intelligence, the majority of research and application efforts during the past century has focused on the utilitarian value of predicting the rank-ordering of individuals on some criterion performance measure. Once one understands this fundamental issue in the study of intelligence, several key concepts must be considered, as follows:

First, intelligence is, more or less, contextually (and culturally) bounded. That is, because performance criteria (such as success in school or work) differ to some degree from one cultural environment to another, the underlying components of intelligence that are relevant to predicting success may differ from one environment to another. For example, 'intelligence' for writing a novel is not *exactly* the same as 'intelligence' for solving calculus problems. That is not to say that these two intelligences are unrelated to one another. Indeed, there are many intelligences that are highly related to each other, which ultimately gives rise to the notion of 'general intelligence' (or *g*).

Second, intelligence is a 'relative' or normative construct. One of Binet's seminal contributions to the assessment of intelligence was to introduce the idea that we can best index intelligence, especially during childhood when rapid cognitive development occurs, as the individual's performance *in comparison to* a reference group (e.g., all six-year-old children). It is almost universally accepted that one can only quantify an individual's intelligence by referring to the reference or norming group. The principal advantage to this approach is that an individual's intelligence is indexed in a way that it has the same meaning, even though norming groups may change from one decade to the next (e.g., in terms of the core knowledge and skills that are within the capabilities of the larger reference group). The principal disadvantage to this approach is that it renders comparisons *across* norming groups somewhat problematic. For example, it is arguably nonsensical to say that a large sample of today's 18-year-olds is more or less 'intelligent' than a large sample of 18-year-olds in 1930. The average 18-year-old today has very different knowledge and skills from the 18-year-old in 1930, in areas of math, science, arts and literature, and so on (see, e.g., Learned & Wood, 1938). An intelligence test designed for 18-year-olds in 1930 would be expected to yield very different performance norms if administered today, yet an IQ score for 18-year-olds in 1930 on a then-current test has the same normative meaning as an IQ score for an 18-year-old today on a current test. The IQ score only tells us the individual's standing with respect to other members of the norming sample.

Third, intelligence is dynamic. That is, although one's IQ score may be relatively constant (e.g., see Thorndike, 1940), the underlying capabilities of the individual (and the reference group) change with age. Over the course of the life span, intellectual development is quite rapid in early childhood, slows in adolescence and early adulthood, and then, for many components of intellectual ability, shows declines in middle-to-late adulthood (e.g., see Schaie, 1996).

Fourth, because prediction is the key determinant of the utility of intelligence assessments, one can make a critical distinction between intelligence *potentiality* and intelligence *actuality.* These terms are derived from Aristotle's *Metaphysics* (see Gill, 2005), but they are especially appropriate for understanding the construct of intelligence, the practicalities of intelligence assessment, and the insights that can be derived from individual intelligence scores. Moreover, as will be introduced later, this particular consideration illustrates the importance of non-ability constructs in the development and expression of intelligence.

Potentiality, in Aristotle's view, can be imagined in terms of a block of bronze (metal). It has the 'potential' to become a statue of a person or many other objects. Yet, in order to realize the goal of a statue, 'work' must be done to transform the block of bronze, by carving or hammering and so on. A completed bronze statue represents an actuality – which is the result of the work done to it by the artist. In terms of intelligence, performance scores on an IQ test are an actuality, but they are not generally of interest, in and of themselves, for many of the reasons provided previously. Consistent with Wechsler's (1975) suggestions, the goal for an intelligence assessment is an index of the individual's *potential* for intellectually demanding learning and task performance. Yet, there are three problems that prevent one from reasonably equating an IQ score with an individual's potential: (a) the test score only represents the individual's actual performance, and as such, potential can only be indirectly inferred (see Anastasi, 1983); (b) although one may be able to make effective predictions of later academic and occupational achievement from a current IQ score, it is impossible to know what future scientific and/or medical developments might be made that would fundamentally change the capability of individuals of different IQ levels to acquire new intellectual skills and knowledge (e.g., so-called brain drugs or new educational instructional techniques); and (c) like Aristotle's example, the translation from the block of bronze to a statue requires the substantial investment of work time and effort on the part of the artist. For an individual to acquire new intellectually demanding knowledge and skills, he/she must invest time and effort, which in turn, implicates non-ability constructs, such as personality and motivation. In the next sections, I will discuss how these key concepts relate to the scientific study of intellectual development and expression.

Adolescent and Adult Intellectual Development

Prior to adolescence in the developed world, nearly all children are subjected to a set of relatively common educational topics (e.g., the traditional reading, writing, and arithmetic). Once they reach early adolescence, however, educational experiences become differentiated across individuals. In addition to core courses in language, math, and sciences, most secondary schools allow students to select a subset of 'elective' or optional courses across the arts, humanities, sciences, and technology domains. These opportunities present both an opportunity and a challenge to researchers who hope to use intelligence assessments for predicting individual differences in subsequent educational and occupational success. The opportunity is represented by the fact that students can choose among courses that have greater or lesser intellectual demands, and they can choose to specialize in a particular domain or to broaden their intellectual horizons across multiple domains. Selective enrollment in these courses provides the researcher with natural experiments, where the researcher can examine differences in the acquisition of knowledge and skills of students who have varied educational experiences. Researchers can examine how such enrollments lead to changes in the depth and breadth of an individual's intellectual repertoire.

The challenge for intellectual assessment, though, is perhaps more daunting than is the opportunity for understanding of intellectual growth and diversification. That is, when students no longer have educational experiences in common, it becomes problematic to compare them using a standard intelligence test. If one student chooses to complete elective courses in Spanish throughout high school, and another student chooses instead to take courses in computer programming, then it becomes difficult to figure out how to rank-order the individuals on their respective levels of intelligence. An intelligence test that included Spanish vocabulary knowledge would put the computer science student at a disadvantage, because he/she would receive no credit for knowledge of computer science, and vice versa. On one hand, an intelligence test that excluded both Spanish and computer science would inadequately sample the knowledge of these individuals, but, on the other hand, an intelligence test that sampled all of the different domains of both in-school elective courses and out-of-school courses of study would be unreasonably long and impractical to administer. This challenge only gets more difficult as students transition from secondary school to higher education or occupations, because the content of their respective intellectual repertoires gets increasingly differentiated and specialized.

The traditional solution to such challenges has been to focus only on what knowledge and skills are common to most students (i.e., not directly sampling knowledge and skills from elective courses), and is further compromised when testing adults, who are many years beyond their high school educational experience. For example, the SAT and ACT tests, used for college/university selection, only assess mathematics knowledge and skills through algebra and geometry, because only a portion of the college-applying population advances to elective courses beyond these topics (e.g., calculus). Four years after the student completes the SAT or ACT, he/she might be considering postgraduate study. Yet, because of the lack of common core courses at the college/university level, the most widely used entrance examination for graduate study, the Graduate Records Examination (GRE) is still only testing algebra and geometry – topics that some students may have only encountered in high school, while other students may have continued with a rigorous study of advanced mathematics at university. Cattell (1957) called this testing of 'historical' crystallized intelligence (Gc), as opposed to 'current' Gc.

As individuals reach adulthood, what they can accomplish on intellectually demanding tasks becomes much more importantly determined by their prior specialized experience. Nearly every profession or expert performance depends on knowledge that has been acquired over a long period of learning and practice. Indeed, I have previously argued (e.g., Ackerman, 1996) that most of the tasks that adults perform on a day-to-day basis are much more highly associated with an adult's specialized knowledge and skills, rather than the kinds of intelligence associated with abstract reasoning and working memory. Jobs that vary broadly share this fundamental property, whether in health care (doctors, nurses), other knowledge work (e.g., accounting, law, science), and in various 'trades' (e.g., carpentry, plumbing). Ultimately, this turns out to be fortuitous for adults, because with increasing age into the middle-adult years, there is typically a decline in the 'fluid' intellectual abilities (Gf), relative to adolescents and younger adults (Cattell, 1943; Hebb, 1942). The implication of these changes is that middle-aged and older adults are less effective in performing abstract reasoning kinds of tasks, that in turn, appear to be important for the acquisition of novel task knowledge and skills. But adults who have acquired expertise in their own professions or other areas often have an advantage in acquiring new knowledge and skills within their own areas of expertise, because transfer-of-training/transfer-of-knowledge is a very powerful positive influence for acquisition of new knowledge, when it can be incorporated into existing knowledge structures (e.g., see Ferguson, 1956).

Intelligence of Young and Middle-Aged Adults

For much of the modern period of intelligence theory and assessment, it has been claimed that intelligence declines in middle-aged years, compared to adolescents and young adults (for a review, see Ackerman, 2000). The evidence for this is somewhat complex, because as noted earlier, IQ scores for different age cohorts – those born in different decades – are fundamentally incommensurable, because intelligence tests are normed for particular cohort groups. Thus cross-sectional studies, where groups of individuals of different age cohorts are given the same intelligence test, yield results where age effects are confounded with cohort differences (Schaie & Strother, 1968). Longitudinal studies, where the same individuals are given the same intelligence test repeatedly, are more informative about the effects of aging compared to cross-sectional studies, but they have other confounds that must be taken into account (such as practice effects). Nonetheless, the accumulated evidence across these studies strongly supports the notion that in adulthood, there is a normative decline in Gf abilities, but much less decline or stability in 'historical' Gc, at least into later adulthood, when there are normative declines, with stronger decline gradients for Gf, compared to Gc (Schaie, 1996). Great efforts have been expended in recent decades to determine factors that may slow or stop the decline of intellectual abilities with increasing age in adulthood, ranging from so-called brain-training games to physical exercise. A discussion of the efficacy of such programs is beyond the scope of this chapter, but see Hertzog and colleagues (2009).

Directly Assessing the Knowledge Components of Intelligence

In studies examining *current* Gc in young and middle-aged adults, we developed tests of content knowledge across a wide spectrum of domains of intellectual expertise. While one cannot reasonably hope to sample all different types of knowledge possessed by adults, we obtained a representative sampling of areas of knowledge that are found in both traditional classrooms and advanced study areas in postsecondary education (e.g., physical and social sciences, literature, art, business, and law), and also domains outside the traditional educational context (knowledge of current events, health and safety, technology, financial planning). Performance was indicated by raw scores rather than norm-based, so that direct comparisons are made between age groups, while keeping in mind that different cohort groups may have different levels of experience and

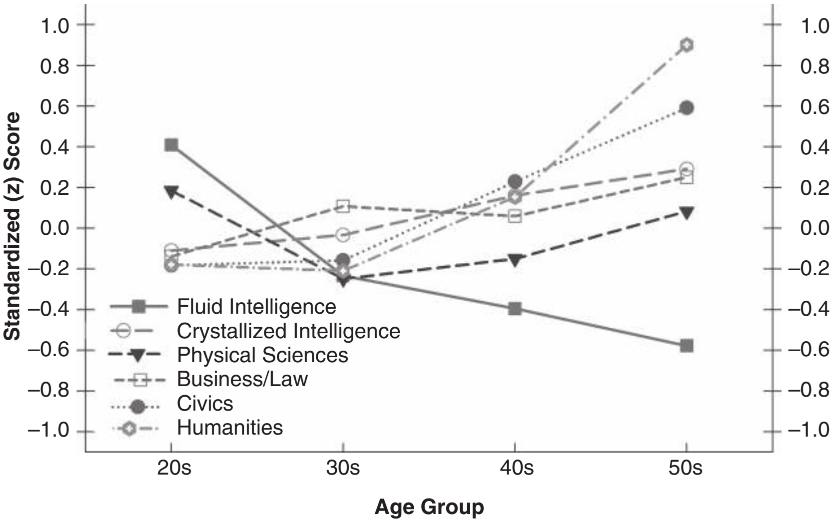

Figure 1.1 Patterns of traditional intellectual ability scores (fluid intelligence and crystallized intelligence) and domain knowledge composite scores as a function of age group in a cross-sectional study (Ackerman, 2000, $N = 228$).
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exposure to the knowledge being sampled. As such, these studies cannot separate aging effects from cohort differences, but they do provide a snapshot of the relative levels of knowledge of different age groups. At the same time, we collected data on traditional measures of Gf and (historical) Gc.

First of all, these studies showed that, consistent with earlier cross-sectional studies, with increasing age, measures of Gf tend to show a decline, while tests of historical Gc are stable or even show small increases. If one were to equally weight Gf and Gc components to yield a general intelligence (*g*) composite, a reasonable conclusion is that older adults are less intelligent, on average, when compared with late adolescents and young adults. In contrast, knowledge assessments show higher levels of average performance among middle-aged adults, with the greatest differences in the areas of the arts and humanities and the smallest differences in the domains of physical sciences (see Figure 1.1 for example results from a study of adults between 21 and 60; Ackerman, 2000). Similar results are found, favoring middle-aged adults in knowledge domains of current events, health, and financial planning (e.g., see Ackerman & Beier, 2006; Beier & Ackerman, 2001, 2003).

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As we have argued elsewhere, there is no *inherent* reason why global estimates of adult intelligence should be based on an equal weighting of Gf and historical Gc measures. Indeed, *if* the goal is to predict the 'actuality' of adult intelligence, meaning a representation of what intellectual tasks an adult can actually accomplish, there are many reasons to prefer a measure that gives greater weight to historical Gc (because of the importance of transfer-of-training in acquisition of new knowledge – see Ackerman & Beier, 2006), and includes a substantial weighting for *current* Gc. Estimates of global intelligence that are designed in this way can be expected to show that middle-aged adults have, on average, higher levels of actual intelligence, compared with adolescent and young adults.

Such a result would be entirely consistent with the notion that if one desired a completed task along a great number of dimensions, such as accounting, law, art, literature, and so on, the greatest expertise would be found among middle-aged adults. However, this is *not* to say that any middle-aged adult would be capable to perform tasks in each of these domains. Rather, as common sense indicates, those adults who have developed expertise in a particular area would be expected to be able to accomplish the respective task successfully. It would be silly to approach a typical skilled carpenter for a radiological consultation, much as it would be nonsensical to ask a typical skilled radiologist to make a wood cabinet. As obvious as these hypothetical examples are, they should give one great pause when researchers or practitioners claim the importance of Gf over historical Gc and current Gc in representing the *actuality* of adult intelligence. Few 18-year-olds, who have the highest raw Gf scores, would be capable, for example, of successfully completing heart bypass surgery or constructing a competent legal argument before a jury.

One interesting finding from these studies is that in contrast to general intelligence assessments, there are many examples of significant, and sometimes profound, sex differences in domain knowledge. There is an important historical reason why there are negligible gender differences in omnibus IQ assessments. That reason is that one individual psychologist, Lewis Terman, decided that boys and girls should have equal scores on his Stanford-Binet intelligence test (Terman, 1916). That is, both Terman and other researchers realized that girls and boys often showed consistent average differences in scores on various intelligence subtests (e.g., verbal, math, and spatial domains). Other researchers suggested that intelligence assessments reflect these differences in whatever manner they appeared, and that separate norms be created for boys and girls, so that an intelligence score would be referenced to the sex of the examinee (Yerkes, Bridges, & Hardwick, 1915). Terman, however, decided that there was adequate justification for equality of IQ scores across the sexes, and so he constructed his IQ test to be specifically balanced by including subtests where the sex differences in the overall scale were eliminated. Subsequent IQ tests generally adopted this same approach to eliminating sex differences.

But, when it comes to individual domain knowledge tests that are content-referenced rather than norm-referenced, sex differences are clearly observed. The majority of the academic domain knowledge tests (e.g., Ackerman & Rolfhus, 1999) show advantages to males, though such differences are not typically found in current-events knowledge tests, and women have a distinct advantage in domains of health knowledge (Beier & Ackerman, 2001, 2003). When one examines sex differences in knowledge tests where the individuals self-select into particular areas of study, these differences are also seen in young adults (College Board, 2011). Ultimately, these results suggest that both individual and sex differences relate to the *direction* and *intensity* of effort devoted to the acquisition of domain-specific knowledge and skills.

Ability and Non-ability Traits and Intellectual Investment

Elementary education is largely a system for transmitting core educational content, and as such, there is great commonality among students in terms of the instruction they receive. Homework, for example, starts off relatively modest in demands for time and effort on the part of students. Once students reach secondary school, they have options toward or away from the investment of their time and effort for acquiring knowledge in intellectually demanding domains. Homework often increases in terms of time and effort, and demands consequently increase for self-regulated cognitive investments. It is during this critical period that an individual's personality and motivational traits appear to increase in influence on the direction and intensity of intellectual investments. For a conceptual discussion of investment and intellectual development, see Cattell (1971; also see Schmidt, 2014; von Stumm & Ackerman, 2013). Intellectual investments continue through decisions about postsecondary education, including whether to attend university study, selection of a major, and choice of early career paths. Together with Gf and both historical and current Gc abilities, non-ability traits also appear to be influential in determining how individuals invest their cognitive resources well into middle adulthood, in terms of seeking out or avoiding intellectual challenges, such as acquiring new knowledge and skills in and out of the workplace, and in terms of refining and improving one's performance on relatively routine tasks.

Several personality and motivational traits are, or become, associated with individual differences in intellectual abilities and domain knowledge during adolescent and adult development. Affective (personality) traits such as openness to experience and conscientiousness are positively related to individual differences in domain knowledge in many areas, while personality traits like neuroticism and extroversion tend to be negatively related to domain knowledge. Similarly, conative (will, motivation) traits such as a mastery orientation or a desire to learn are positively related to individual differences in domain knowledge, while worry and anxiety in achievement contexts are negatively related to individual differences in domain knowledge. In addition, there is a moderate association of vocational interests to differences in domain knowledge, such as investigative interests and artistic interests being positively associated with domain knowledge in the sciences and humanities, and a negative association between social and enterprising interests and a variety of academic knowledge domains. These non-ability traits are related to one another, even though they represent different aspects of individuals. This commonality has been a major factor in the development of the concept of "trait complexes" (Ackerman & Heggestad, 1997) – that is, constellations of personality, motivation, and other traits that: (a) appear more frequently in the population, and (b) are associated with orientations toward or away from intellectual development. Trait complexes of intellectual/cultural traits and science/math traits are associated with higher levels of domain knowledge in the arts, humanities, and social sciences, and in STEM (science, technology, engineering, and math) domains, respectively. Complexes of social and conventional traits are associated with lower levels of knowledge in a variety of academic and other intellectually demanding domains (Ackerman, 2000). Based on these considerations, a general framework for understanding adult intellectual development can be illustrated as shown in Figure 1.2.

In the figure, early adolescent intellectual potentiality is represented in terms of what is measured with an IQ test, that is, Gf and historical Gc. As individuals develop into adulthood, non-ability trait complexes interact with levels of intellectual potentiality to determine the investment (time and effort) the individual makes into one or more of a variety of different directions, both intellectual and non-intellectual. The result is found in an adult's breadth and depth of domain knowledge and skills, which represent the vocational and avocational (e.g., hobbies) intellectual repertoire of the individual. I propose this is the *main* source of individual differences in