PART I
Introduction

1 What Is Intelligence and What Are the Big Questions about It?

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Some people are better at some things than others; some of those people who are better are better not only at some things, but at lots of things. The study of intelligence evolved in part to try to explain these individual differences. As time has gone by, the field of human intelligence has addressed many other questions as well. But this question of accounting for individual differences in performance that seem at least in part based on "mental abilities" has driven the field ever since its beginning.

What Is Intelligence?

What is intelligence, exactly? There is no one definition that has garnered universal acceptance, but over the last 100 years, intelligence has been defined in some of these ways:

> It seems to us that in intelligence there is a fundamental faculty, the alteration or the lack of which is of the utmost importance for practical life. This faculty is judgment, otherwise called good sense, practical sense, initiative, the faculty of adapting one's self to circumstances. (Binet & Simon, 1916, pp. 42-43)

> Intelligence is the aggregate or global capacity of the individual to act purposefully, to think rationally and to deal effectively with his environment. (Wechsler, 1940, pp. 444-445)

> Individuals differ from one another in their intelligence – their ability to understand complex ideas, to adapt effectively to the environment, to learn from experience, to engage in various forms of reasoning, to make good decisions, and to solve problems. Although these individual differences can be substantial, they are never entirely consistent: A given person's intellectual performance will vary on different occasions, in different domains, as judged by different criteria. Concepts of "intelligence" are attempts to clarify and organize this complex set of phenomena. (Neisser et al., 1996, p. 77)

Although these definitions differ somewhat, they share the idea that **intelligence** involves the ability to learn new concepts, to form judgments with those concepts, and to solve problems based on those concepts (see also Sternberg, 1997; Sternberg & Hedlund, 2002). Intelligence differentiates people according to the kinds and

difficulties of mental tasks they can perform to meet their adaptive needs. Intelligence also can be viewed at a species level, comparing, say, humans to other species such as monkeys or dogs. Such comparisons are extremely challenging, however. They tend to be made in terms of skills that are adaptive for humans or skills that humans imagine are adaptive for the other animals. For example, a dog's idea of an intelligent dog owner may differ from the dog owner's idea!

Some Big Questions about Intelligence

There is no universal agreement about which questions are most important to understanding intelligence, but there are some big questions that have persisted over the years. Some of these questions have been answered by different types of research over time and some are still in the process of being addressed. We will highlight these questions here and then spend the rest of the book delving more deeply into each of them.

Is There Such a Thing as Intelligence?

How did people come up with a construct such as intelligence anyway? Where did the concept come from? Intelligence was recognized in some form by the ancient philosophers. For example, Plato, who made his major contributions in the fourth century BC, had a great deal to say about intelligence. One aspect of intelligence that he wrote about is the ability to learn. In Plato's *Republic* Book 5, Socrates asks Glaucon:

> When you spoke of a nature gifted or not gifted in any respect, did you mean to say that one man will acquire a thing easily, another with difficulty; a little learning will lead the one to discover a great deal; whereas the other, after much study and application, no sooner learns than he forgets; or again did you mean, that the one has a body which is a good servant to his mind, while the body of the other is a hindrance to him? – Would not these be the sort of differences which distinguish the man gifted by nature from the one who is ungifted? (*Great Books of the Western World,* 1987, *5,* 359)

Glaucon agrees with Socrates that his observations are correct. Socrates further demonstrates to Glaucon that part of human intelligence is the love of learning and knowledge; truthfulness and unwillingness to accept falsehoods, and indeed, love of the truth.

Love of truth today more likely might be classified as wisdom than as intelligence (see Sternberg & Jordan, 2005), but the idea that people can infer the truth and distinguish it from falsehood is very much alive in the notion of inductive reasoning as a key part of intelligence, ranging back to Charles Spearman (1923) and continuing with modern theories of intelligence (Sternberg, 2018).

In another work by Plato, the *Theaetetus*, the boy Theaetetus imagines that there exists in the mind of man a block of wax, which is of different sizes in different men. The blocks of wax can also differ in hardness, moistness, and purity. In this dialogue, Socrates suggests that when the wax is pure and clear and sufficiently deep, the mind will easily learn and retain and will not be subject to confusion. It only will think things that are true, and because the impressions in the wax are clear, they will be quickly distributed into their proper places on the block of wax. But when the wax is muddy or impure or very soft or very hard, there will be defects of the intellect. People whose wax is soft will be good at learning but apt to forget. People whose wax is hard will be slow to learn but will retain what they learn. People whose wax is shaggy or rugged or gritty, or whose wax has an admixture of earth or dung, will have only indistinct impressions. Those with hard wax will have the same, because there will be no depth to the thoughts. If the wax is too soft, the impressions will be indistinct, because they can be easily confused or remolded (*Great Books of the Western World,* 1987, *7,* 540).

Plato's theory, as expressed in the dialogue, is a rather primitive metaphor of mind. But scientists still speak of brains as modifiable in varying degrees (Haier, 2017), and although they may not think of the brain as a ball of wax, they have simply replaced that concept with more modern biology, recognizing the roles of neurons, synapses, and interconnectivity in place of Plato's wax.

Aristotle, the third giant of Greek philosophy after Socrates and Plato, also had some fairly sophisticated views on the nature of intelligence. Aristotle lived in the fourth century BC. In the *Posterior Analytics* Book 1, he conceived of intelligence in terms of "quick wit":

> Quick wit is a faculty of hitting upon the middle term instantaneously. It would be exemplified by a man who saw that the moon has a bright side always turned towards the sun, and quickly grasped the cause of this, namely that she borrows her light from him; or observes somebody in conversation with a man of wealth and defined that he was borrowing money, or that the friendship of these people sprang from a common enmity. In all these instances he has seen the major and minor terms and then grasped the causes, the middle terms. (*Great Books of the Western World,* 1987, *8,* 122)

Aristotle essentially was recognizing the importance of deductive reasoning to intelligence. Indeed, syllogisms of the form "All men are mortal. Socrates is a man. Therefore, Socrates is mortal" are referred to as Aristotelian syllogisms. In the early form of Louis Thurstone's (1938) theory of intelligence, deductive reasoning was identified as a factor, although it later was subsumed under other factors. And modern information-processing work has recognized deductive reasoning as an important part of intelligence (e.g., Sternberg, Guyote, & Turner, 1980; Sternberg & Weil, 1980). Aristotle's discussion of the conversation with the man of wealth also shows a sensitivity to the concept of social intelligence

(Kihlstrom & Cantor, 2011; Sternberg & Smith, 1985) or what Gardner (2011) calls "interpersonal intelligence."

So the concept of intelligence has a long history. One might wonder if we need it. But as long as people differ in their skills in solving real-world problems, people will invent a concept like intelligence, whether they call it "intelligence" or "aptitude" or "ability" or something else. In other words, one cannot say for certain that there is any one thing in the brain that constitutes intelligence, although some theorists believe there most likely is (Deary, 2000; Jensen, 1998; Spearman, 1927). But functionally, when people engage in tasks and solve problems, and when they differ in how well they do at them, there always will be a need for some concept like intelligence, whatever it may be called. And moreover, because different species also differ in what they can accomplish, the concept of intelligence seems to serve an evolutionary purpose as well as an individual-differences one (Jerison, 1982; Zentall, in press).

Is Intelligence a Single Thing or Many Things?

Scholars studying intelligence have had diverging views regarding whether intelligence is a single entity or a multifaceted one (Sternberg & Grigorenko, 2002). A major early twentieth-century theorist, Charles Spearman (1927), believed that intelligence has multiple facets, but that a single one, which he referred to as **general intelligence** (or *g*), predominates. Louis Thurstone (1938) disagreed, suggesting seven aspects to intelligence, all of which he believed to be important. To this day, psychologists disagree as to whether intelligence is predominantly one thing (Gottfredson, 1997) or many (Gardner, 2011; Sternberg, 1985a, 1985b, 1986). Many contemporary theorists somewhat bypass the issue, suggesting that intelligence can be understood hierarchically, with a general intelligence factor at the top of a hierarchy of abilities and more specific abilities at successive levels below that (e.g., Carroll, 1993; see Walrath, Willis, Dumont, & Kaufman, in press).

Figure 1.1 shows a schematic of Spearman's, Thurstone's, and Carroll's theories of intelligence. Note that each theory proposes not only somewhat different abilities, but also different structures for those abilities in the mind. Chapter 2 describes in more detail how psychologists have defined general intelligence and introduces the major approaches used to study intelligence.

Is Intelligence the Same Thing in All Places and at All Times?

Many theorists of intelligence have studied intelligence as though it is an entity the nature of which transcends time and space. In other words, they believe that it is the same thing, regardless of time and place. Most theories of intelligence have been constructed on the basis of the notion that intelligence is a thing that is unchanging across time and space.

Western cross-cultural researchers in much of the twentieth century believed that intelligence is the same everywhere, so they translated standard intelligence tests

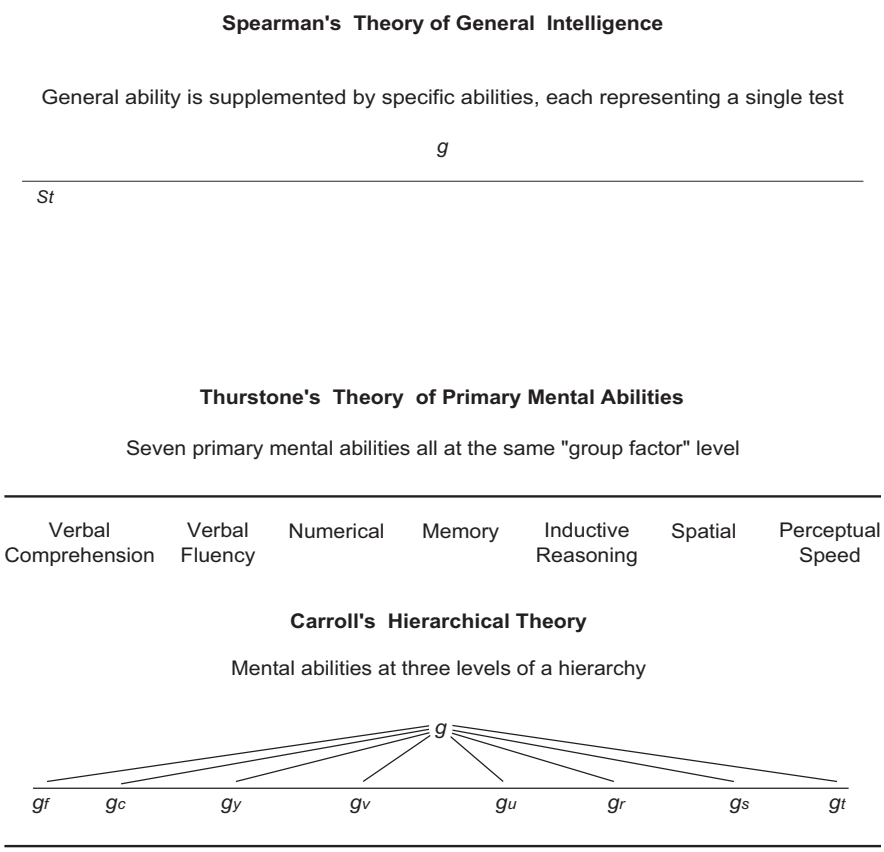

Figure 1.1 Hierarchical models of intelligence. Spearman believed that the most important aspect of intelligence was a single entity, general intelligence, or *g*. Thurstone believed that there are seven primary mental abilities, all of roughly equal importance. Carroll and other hierarchical theorists suggested that abilities can be arranged in hierarchical form. Different hierarchical theorists have proposed somewhat different hierarchies, but all their models have in common that they postulate differing levels of generality of abilities.

and then used them in non-Western cultures. Typically (but not always!), people in these other cultures did worse on the tests to the extent that the cultures diverged from the norms of Western Civilization. The traditional view was that people in these other cultures (or subcultures) just were not as bright as Westerners. Some psychologists still hold this view. A different viewpoint (Greenfield, 1997; Rogoff, 2003; Sternberg, 2004) holds that, to be fair, the tests need to be tailored to the real-life adaptive demands of a particular culture. Chapter 7 discusses these cultural approaches to intelligence in depth. For example, children in some cultures may be unfamiliar with the kinds of stimuli and the knowledge required to do well on a standard Western test of intelligence. At the same time, many Westerners might be

unfamiliar, today, with the hunting, fishing, and gathering skills needed for adaptation elsewhere. Knowing what plants to eat and not eat, and which animals were dangerous and which ones were not, would have been important for daily survival in some cultures. In times past, the technological skills that are so important in today's world would have been irrelevant, but hunting skills might have meant the difference between surviving and perishing. Perhaps intelligence, as we know it today, predicts practical adaptive kinds of knowledge and skills, but it is hard to say just how good the prediction is.

Have Levels of Intelligence Changed over Time?

Psychologists used to believe that levels of intelligence have remained fixed over time, at least in the modern day. After all, the average IQ (intelligence quotient) is 100; it is 100 now and was 100 a century ago and still will be 100 a century from now. Indeed, one of the things every first-year psychology student learns is that the average IQ is 100.

But James Flynn (2011) looked more deeply into this presupposition and found it to be true only in the most superficial sense. On the one hand, it is true that the average IQ always has been and probably always will be 100. But what he realized is that, because test publishers create new norms (conversions of *raw scores*, or numbers of items answered correctly, to IQs) every so often, 100 at any given time does not have to mean exactly the same thing as 100 at a different point in time.

In fact, as you will learn in Chapter 10, average IQs have changed over time. They have risen substantially – as much as 30 points during the twentieth century – meaning that an IQ of 100 in the year 1900 was the equivalent of only about 70 in the year 2000. Thus, we cannot assume that levels of intelligence always remain the same. And because evolution does not operate, at least for humans, on a time scale of 100 years, we can conclude that environment somehow must play an important role in affecting people's level of intelligence. Intelligence changes in response to the demands of the environment – when those demands on intellect increase, intelligence can rise; when those demands decrease, intelligence can fall (Flynn, 2011).

Is There a Best Way to Study Intelligence?

Scholars sometimes hope that there will be one *best* way to study scientific phenomena, whether the phenomenon is intelligence or anything else. In the early twentieth century, most psychologists studying intelligence used complex statistics to derive and test their theories. (Chapters 2, 3, and 4 explore the science of measuring intelligence.) In the latter part of that century, many psychologists instead turned to trying to understand the mental processes underlying particular abilities, such as verbal or mathematical ability. Other psychologists used cultural methods to understand intelligence, and still others biological methods. There is no one "right" or "best" way to study intelligence. Each method tells us things about intelligence that other methods may miss. If one wants to understand how the brain

is related to intelligence, a biological approach (as described in Chapter 6) is almost certainly best. If one wants to understand the mental processing underlying intelligence, a cognitive approach is best. (Cognitive approaches are covered in Chapter 5.) If one wants to understand intelligence by looking at extreme groups, an approach is best that emphasizes intelligence toward the top and bottom of the intelligence scales. (Chapter 12 explores the extremes of intelligence.) And if one wants to understand how intelligence manifests itself differently across cultures, one may instead choose cultural methods for one's investigations, as described in Chapter 7.

Is There a Best Test of Intelligence?

There are a variety of tests of intelligence, and these are explored in Chapters 2 and 4. Most of these tests are chronicled in the *Buros' Mental Measurements Yearbook*. By far, the two most widely used tests are the series by David Wechsler (2008) and the Stanford-Binet (Roid, 2003), which are described in later chapters. A nonverbal test called the Raven Progressive Matrices (Raven, Raven, & Court, 2003) also is widely used. But of course, widespread use does not necessarily translate into "best."

If one is talking about intelligence as it is commonly operationalized in standardized tests, the Wechsler and Stanford-Binet are probably good choices. But at another level, it is not clear that the exact choice of test matters all that much. The reason is that almost all these tests measure more or less the same thing, general intelligence plus some other related factors. So it often does not make a great difference which test is chosen, given that most of them correlate rather highly with each other.

When most of the early tests of intelligence were created, they were not closely tied to any particular theories of intelligence. Today, many intelligence tests yield subscores based on one or another theory of intelligence, often Carroll's (1993) three-tiered theory, which has three levels of mental abilities (and is described in detail later).

Some test users would prefer tests based on other ideas, such as expanding measurement of intelligence to include creative and practical as well as analytical skills (e.g., Sternberg, 2018). Although such assessments exist (e.g., Sternberg, 2018), they are not ready for prime time in terms of measuring individual intelligence. It may be some years before viable alternatives are available. Figure 1.2 shows examples of what items measuring analytical, creative, and practical skills might look like.

A question one might want to ask before choosing a particular test is exactly why one wishes to measure someone's intelligence. Although intelligence testing used to be fairly commonplace, especially in schools, it is much less common today. Schools typically no longer routinely test the intelligence of their students, although they may do so for special program placements, such as for entry into a gifted program or a program for students with intellectual challenges or disabilities.

Analytical

1. What number comes next in the following series?

2, 5, 9,14,20,_____ a. 25, b. 26, c. 27, d. 28

2. In the morning, the BLEN arose on the horizon.

What does BLEN mean? a. sun, b. moon, c. asteroid, d. water

3. What is your favorite book? Why is it your favorite book? What are its strengths and weaknesses?

Creative

1. Suppose Germany had won World War II. What would the world be like today?
2. Draw an advertisement for asparagus.
3. Write a story with the title "Beyond the Edge."

Practical

1. How might you convince a friend to help you move from one place to another?
2. If you wanted a teacher to write the best possible letter of recommendation for you, what might you say to the teacher?
3. What kinds of clues might you use to figure out whether someone is lying to you?

Figure 1.2 Examples of items measuring analytical, creative, and practical skills

But even in these cases, it often is not clear why an intelligence test is needed in addition to, much less instead of, tests of achievement in targeted areas (Spear-Swerling & Sternberg, 1994).

In sum, there probably is no one "best" test, but there are many tests available – verbal, nonverbal, a combination of verbal and nonverbal, performance based among them – that can suit a fairly wide variety of needs. At the same time, it is important to remember that the tests all represent, whether openly or not, particular conceptions of intelligence, and they are only as good as the particular conception of intelligence and its applicability to the individuals being tested.

Is Intelligence Heritable?

In the twentieth century, as you will learn later, some psychologists were preoccupied – perhaps, in some cases, obsessed – with the heritability of intelligence.

Heritability refers to the proportion of variation in intelligence among individuals that is due to genetic effects (Plomin et al., 2012). In other words, when one looks at variations in intelligence among people, what proportion of it is a result of genes? But fixating on the heritability of intelligence may not be such a great idea. Heritability is not some fixed number waiting to be discovered. Heritability depends on many factors, especially the range of genetic variation and environmental variation in a population of people of interest. For reasons that we explore in Chapter 9, heritability tends to be higher when the range of environments is more narrow and lower when the range of environments is broader. Similarly, heritability is higher when the range of genes related to intelligence is more variable and lower when the range of genes related to intelligence is reduced. The details, at this point, are not important. What is important is to realize that there is no one fixed number that represents how heritable intelligence is. Moreover, how heritable intelligence is also will depend on how one measures intelligence. The early search for a "true" heritability of intelligence was misguided.

There is one more important fact to understand. Heritability is not the same as a trait's being fixed or unmodifiable. Levels of a trait can be modifiable, even highly modifiable, even when heritability is high. Height is a good example. Height is highly heritable (with a heritability of about .9 on a 0–1 scale) in a typical Western population, yet heights are highly modifiable, having increased very substantially from even the beginning of the twentieth century until today. When I was growing up in the latter part of the twentieth century, most of us young men were taller than our fathers. As we saw, levels of intelligence also increased during the twentieth century, but the increase told us nothing about heritability. Heritability is a mechanism of transmission of traits from one generation to another, but levels of traits can vary as a function of nutrition, availability of good medical care, and other factors.

Table 1.1 illustrates how a trait, height, can be highly heritable yet highly modifiable.

Can Intelligence Be Increased (or Decreased)?

Intelligence is at least somewhat modifiable (Ceci, 1996; Feuerstein, 1980; Nickerson, 2011; Detterman & Sternberg, 1982; Jaeggi et al., 2008). That is, with good education and good parental investment, parents and teachers can raise their children's intelligence. (Chapter 16 explores the relationship of intelligence and education.) Probably the best way to raise intelligence, at least for children, is just to go to school, and preferably a good school. It also helps greatly to have parents who care about developing their children's intellectual skills.

At the same time, there is no evidence that it is possible, in large number of cases, to obtain huge increases in people's intelligence. The differences one gets through excellent education are observable but they are not astronomical. Programs that