

The Essence of General Intelligence

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Abstract: General intelligence (g) refers to a critical cognitive ability that has been well characterized by cognitive neuroscientists and psychologists. It is one of the most pervasive concepts in psychology. It is measured by psychological tests and is often stated in the form of intelligence quotient (IQ). Tests that are g-loaded are among the best predictors of success in school and workplace. Higher general intelligence is often associated with educational and occupational successes. This paper provides an introduction to general intelligence.

Keywords: *General Intelligence, Academic Intelligence, Intelligence Quotient*

I. INTRODUCTION

Humans have been interested in intelligence since our earliest written history. Intelligence can be regarded as a general mental ability that involves being able to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly, and learn from experience. It is a complex characteristic of cognition. The standard view in the field of human intelligence has been that there is a “general intelligence” (GI) that permeates all human cognitive activity.

There are consistent individual differences in human intelligence, attributable to a single “general intelligence” factor, *g*. Although intelligence is often studied in humans, it has been observed in animals and plants. In humans, performance on diverse tests of cognitive ability show positive correlations with a single factor, termed general intelligence or ‘*g*’ [1]. High general intelligence (IQ) has evolved with convergent evolution in nonhuman animals such as capuchins, baboons, macaques, and apes.

II. WHAT IS GENERAL INTELLIGENCE?

Intelligence refers to the ability to think, to learn from experience, to solve problems, and to adapt to new situations. It can be quantified across species and is heritable. Humans share with other species a core set of genetically specified constraints on intelligence. General intelligence (GI) accounts for the overall differences in intelligence among people. It is correlated with gender (men scored higher than women), age (younger scored higher elderly), and brain size (larger brains scored higher). This largely explains male dominance in most cultures and the idea that smarter people have bigger brains. Intelligence can have different meanings and values in different cultures. What is considered “intelligent” in one culture may be different from those considered intelligent in another.

In the 1900s, scientists reduced intelligence down to a single digit: the *g* factor. The idea of IQ is based on a “*g* factor” or “generalized intelligence.” Social and economic deprivation can negatively affect IQ. Intelligence is improved by education. General intelligence is a cognitive process in that it gives humans the cognitive abilities to learn, understand, and reason.

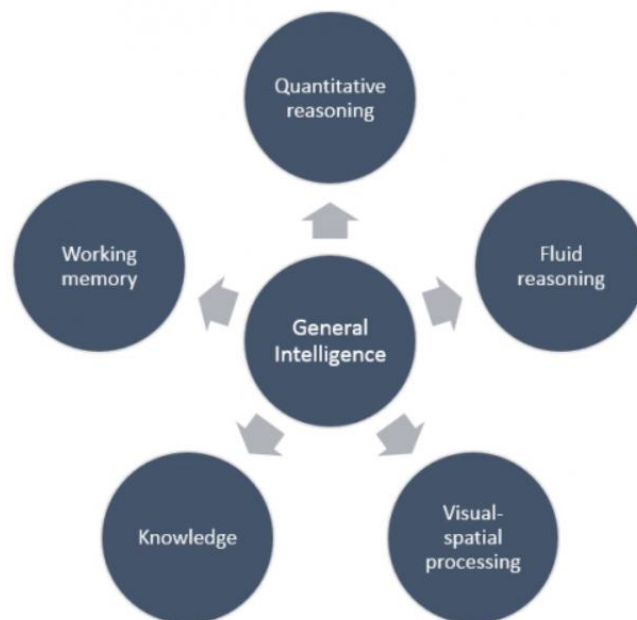


Figure 1: Various cognitive factors that make up general intelligence [2]:

As illustrated in Figure 1, the various cognitive factors that make up general intelligence include [2]:

- Quantitative reasoning: the test that involves capacity to solve numerical problems
- Fluid reasoning: flexible thinking to solve problems
- Visual-spatial processing: ability to put together puzzles and copying complex shapes
- Knowledge: a person’s knowledge about vast array of topics
- Working memory: capacity of the short term memory, such as repeating a list

Many theories have been developed to explain what intelligence is and how it works. One popular theory is Sternberg’s triarchic theory of intelligence. According British psychologist Robert J. Sternberg, intelligence has three aspects: analytical, creative, and practical [3]:

- *Analytical Intelligence*, also referred to as componential intelligence, refers to intelligence that is applied to analyze, evaluate or critique and arrive at solutions. It is displayed when the components of intelligence are applied to analyze, evaluate, judge, or compare and contrast. This is what a traditional IQ test measures.
- *Creative Intelligence* is the ability to solve new problems quickly. It is the ability to go beyond what is given to create, invent, and create new solutions. This type of intelligence involves imagination, innovation, and problem-solving. Creativity may include finding a novel solution to an unexpected problem. People are often creative in some domains,

but not in others. High creative people usually have intense knowledge about an idea, work on it for some time, look at novel solutions, seek out the advice of others, and take risks. Creativity thinking skills can emerge as both potential and performance factors.

- *Practical Intelligence* is the ability that individuals use to solve problems faced in daily life. It represents a type of street smarts or common sense that is learned from life experiences (especially from mistakes) and cannot be gained from books or formal learning. Learning is perhaps the best way to improve your practical intelligence. Tacit intelligence is an important component of practical intelligence, consisting of knowledge which is required in many real-life situations.

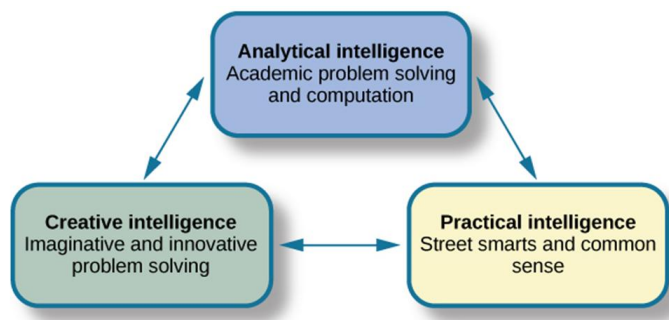


Figure 2: Sternberg's theory identifies three types of intelligence [4].

Figure 2 shows Sternberg's triarchic theory of intelligence [4]. This theory of intelligence provides a good way of understanding human intelligence. The ability to achieve lifelong success largely depends on a balance of analytical, creative, and practical abilities, a balance which is achieved in order to adapt to, shape, and select environments. Analytical, creative, and practical tests have been used to predict mental and physical health among Russian adults.

Intelligence changes with age. IQ is a score obtained by dividing a person's mental age score, obtained by administering an intelligence test, by the person's chronological age, both expressed in terms of years and months. That is, IQ is determined by using the following formula [5]:

$$\text{IQ Score} = \text{mental age (MA)} \div \text{chronological age (CA)} \times 100$$

Thus an 8-year-old child who does as well as the average 10-year-old child would have an IQ of 125 ($10 \div 8 \times 100$).

III. MEASURES OF THE INTELLIGENCE QUOTIENT

Individuals differ in their ability to reason, solve problems, think abstractly, plan and learn. Scores from intelligence tests are estimates of intelligence. The intelligence quotient (IQ) is a measure of intelligence that is adjusted for age. Intelligence tests are among the most reliable and valid, of all psychological tests for the assessment of intelligence. The IQ is the main determining factor in one's ability to manage formal school education; the ability to learn, process, and repeat information. Over the years, a number of scales of the IQ have been developed.

The IQ test, or the measure of the intelligence quotient, was first developed by the English psychologist Charles Spearman in Europe in the 19th century. He measured human intelligence using the general intelligence g factor, which is a psychometric construct that summarizes the correlations

observed between an individual's scores on a wide range of cognitive abilities. According to Spearman, general intelligence (or g factor) refers to a general mental ability that, underlies multiple specific skills, including verbal, spatial, numerical, and mechanical. These are the skills usually examined to determine the intelligence quotient. These are illustrated in Figure 3 [3].

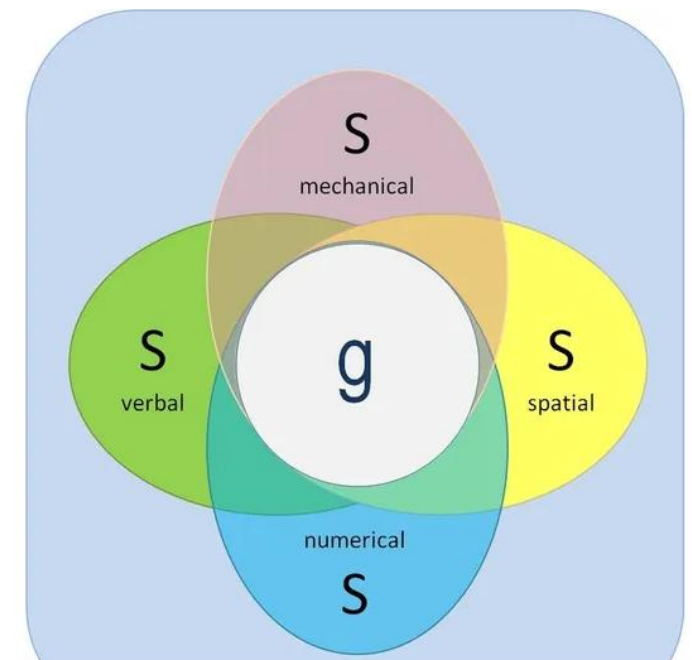


Figure 3 Spearman's representation of an individual's general intelligence across multiple abilities [3].

The g factor typically accounts for 40 to 50 percent of the between-individual performance differences on a given cognitive test. IQ scores are often normally distributed, meaning that roughly 95% of the population has IQ scores between 70 and 130. The average score for the test is 100, and any score from 90 to 109 is considered to be in the average intelligence range. Score from 110 to 119 are considered to be High Average. Superior scores range from 120 to 129 and anything over 130 is considered Very Superior or gifted.

The most widely used intelligence test for adults is the Wechsler Adult Intelligence Scale (WAIS Fourth Edition or WAIS-IV). This is a comprehensive modern intelligence assessment, standardized on 2,200 people ranging from 16 to 90 years of age. It comprises tasks that assess several aspects of intelligence [6]:

- verbal comprehension (e.g. word definition, general knowledge and verbal reasoning)
- visuo-spatial reasoning (e.g. puzzle construction, matrix reasoning and visual perception)
- working memory (e.g. digit span, mental arithmetic and mental manipulation)
- mental-processing speed (e.g. reaction time for detection).

The scores on all of these tasks are tallied to calculate a standardized Full Scale Intelligence Quotient (FSIQ) score. IQ researchers sum standardized subtest scores to calculate general intelligence.

Alfred Binet developed a scale in 1905 in France with the collaboration of Thomas Simon. The scale is known as the Binet-Simon scale and it has become the basis for the intelligence tests still used today. The Binet-Simon scale

comprised 30 items designed to measure judgment, comprehension, and reasoning which Binet deemed the key characteristics of intelligence.

IV. APPLICATIONS

Some applications of general intelligence include the following [7-9].

- *Education:* The pursuit of intelligence in education is very important. ACT, SAT, GRE, etc. are all barometers of students intelligence. Teaching analytically, creatively, and practically in a cultural setting can make a difference in school achievement. Educators in general have made use of Binet's conception of general intelligence. A student with superior general intelligence will show greater initiative and will possess superior ability to adapt himself.
- *Academic Achievement:* According to research by Robert L. Thorndike, 80 to 90 percent of the predictable variance in scholastic performance is due to *g*. *g* is closely related to the ability to learn novel material and understand concepts. In elementary school, the correlation between IQ and grades and achievement scores is between .60 and .70. Achievement test scores are more highly correlated with IQ than school grades. The SAT is primarily a measure of *g*. In elementary school, the correlation between IQ and grades and achievement scores is between .60 and .70. In high school, college, and graduate school the validity coefficients are .50-.60, .40-.50, and .30-.40, respectively. Achievement test scores are more highly correlated with IQ than school grades. This may be because grades are more influenced by the teacher's idiosyncratic perceptions of the student. In a longitudinal English study, *g* scores measured at age 11 correlated with all the 25 subject tests.
- *Job Attainment:* The dispersion of general intelligence scores is smaller in more prestigious occupations than in lower level occupations, suggesting that higher level occupations have minimum *g* requirements. At the level of individual employees, the association between job prestige and *g* is lower – one large U.S. study reported a correlation of .65 (.72 corrected for attenuation). *g* has a number of correlates in the brain.
- *Job Performance:* Research indicates that tests of *g* are the best single predictors of job performance. *g* has predictive validity even for the simplest jobs. The hiring process has relied on standard psychometric measures of general intelligence, as predictors of job performance. Research also shows that specific aptitude tests tailored for each job provide little or no increase in predictive validity over tests of general intelligence. It is believed that *g* affects job performance mainly by facilitating the acquisition of job-related knowledge. General cognitive ability (GCA) remains as the best predictor of job performance. An employee with low general cognitive ability (GCA) will compensate his/her task performance. People high in GCA are capable to learn faster and acquire more job knowledge easily, which allow them to perform better. GCA affects acquisition of job knowledge, which in turn improves job performance. Males generally

outperform females in spatial tasks, while females generally outperform males in verbal tasks. This explains the presence of greater numbers of males than females in engineering and technology.

- *Intelligence Tests:* Many new intelligence tests have developed lately. Undergraduate admission into universities relies on specific aptitude and achievement tests such as the Scholastic Assessment Test (SAT) or the American College Test (ACT). For example, the ACT is strongly *g* loaded. Graduate admission requires the Graduate Record Examination (GRE), Graduate Management Admission Test (GMAT), Medical College Admissions Test (MCAT), or the Law School Admission Test (LSAT). These tests have become an integral part of our lives. For example, the Educational Testing Service does not claim that it measures general intelligence, but that the SAT measures verbal and mathematical reasoning abilities.

Other applications of GI include income, occupation, crime, performing artists, and games.

BENEFITS AND CHALLENGES

General intelligence is a robust predictors of conventional measures of educational achievement, job performance, job satisfaction, training performance, socio-economic success, social mobility, health, and longevity. General intelligence is strongly related to working-memory capacity or memory span. Intelligent people can solve problems better than less intelligent people. Success in life largely depends on general intelligence. General intelligence has been shown to enhance individuals' care of their own health and well-being through effective learning skills. It is at the root of our unprecedented technological achievements and is the basis for modern civilization.

However, there is considerable debate about what general intelligence really is, how best to measure it. Critics of general intelligence often allude to the fact that no single measurement can do justice to the complexity of people's mental abilities. It has been argued that IQ tests are biased in favor of white, middle-class people. Since the majority of the world's population does not live in Europe or North America, the cultural specificity of the IQ tests is crucial. Some psychologists argue that intelligence is genetic, or inherited, while others claim that it is largely a general ability which can be developed.

CONCLUSION

General intelligence is the measure of cognitive ability that has received more attention than any other form of intelligence. The existence of GI as a single measure of intellectual ability is orthodoxy among psychologists and the general public. General intelligence is a general mental capability to reason, think abstractly, solve problems, plan and learn across domains. The nature of general intelligence has been studied by many investigators. Individuals with high general intelligence (or high *g* scores) will be those usually performing well. For more information about general intelligence, one should consult the books in [10-16].

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