

Intelligence- Hierarchical

Brooke Maston, M.A.

Donna DeV Vaughn Kreskey, Ph.D.

California State University, Chico

Within the field of psychology, intelligence is usually defined using a psychometric approach. This approach relies on the use of psychological measurement, or standardized tests, to objectively measure the cognitive processes and skills of an individual and compare them to the processes and skills of a norm group that represents the general population. Historically, psychologists who studied human intelligence fell into two major groups. One group, which included psychologists such as Charles Spearman, Phillip Vernon, and John Carroll, favored a single general factor comprised of a variety of specific factors to explain intelligence. The second group, which included psychologists such as Edward Thorndike, Louis Thurstone, Raymond Cattell and John Horn, favored a multi-factor model of intelligence. This group maintained that intelligence is a composite of several different and independent abilities. Current hierarchical models of intelligence represent a merging of these early views of intelligence. They propose that overall intelligence can be measured as a single factor, but multiple distinct and measurable factors that uniquely contribute to an individual's overall ability.

Current methods of Intelligence testing in the field of psychology, build on the work of Charles Spearman in the early 20th century. Spearman observed that children's performance across seemingly unrelated academic subjects was positively correlated. Based on his observations, he theorized that human intelligence is an overarching general cognitive ability. This overarching cognitive ability, or g factor, is comprised of many different specific skills he

called s factors. Various tests of intelligence measured different s factors, but all intelligence tests were measures of g. Spearman's conceptualization of the g factor is represented as the top of today's hierarchical factor models of intelligence. It accounts for an individual's cognitive abilities across all domains of intelligence. This g factor is more commonly referred to in intelligence testing as one's IQ, or intelligence quotient.

In contrast, Gf-Gc Theory (1967) is an example of a multi-factor theory of intelligence. Raymond Cattell proposed, and John Horn later expanded, the idea that human ability, or what Spearman referred to as g, is composed of two distinct types of intelligence. The first is called fluid reasoning and abbreviated Gf. It is the ability to solve novel problems independent of previously acquired knowledge. The second is named crystallized intelligence and abbreviated Gc. It represents the knowledge and skills gained from exposure to one's culture. It is dependent on formal and informal education throughout the lifespan. Gf-Gc theory proposed that an individual's use of the knowledge gained from life experiences, their Gc, combined with their ability to solve novel problems, their Gf, make up one's overall intelligence. Cattell's conceptualization of multiple intelligence factors is also reflected in today's hierarchical factor models of intelligence.

Three-Stratum Theory of Intelligence proposed by John Carroll (1993) is an example of a hierarchical model of intelligence. This theory describes intelligence as consisting of three strata or levels. The three levels include narrow abilities, or those skills that Spearman referred to as specific factors, at the bottom. These narrow abilities are contained within broad abilities in the middle. Carroll's model included Gf and Gc, as described by Cattell and Horn, among the multiple broad abilities that comprise general intelligence. All broad abilities are subsumed under general cognitive ability, or g. Carroll's Three-Stratum model accounted for distinct,

stable, and observable differences amongst individuals' performance across the various tasks included on intelligence tests.

Widely regarded as a comprehensive and empirically supported hierarchical theory of intelligence, Cattell-Horn-Carroll, or CHC Theory, integrates and builds upon the earlier work of Charles Spearman, Raymond Cattell, John Horn, and John Carroll. CHC Theory consists of two components: a taxonomy, or list, of cognitive processes and abilities, and a set of theoretical explanations of how and why individuals have different patterns of cognitive ability. CHC theory maintains the three-stratum hierarchy originally proposed by Carroll. It also incorporates current research findings that support the inclusion of broad and narrow abilities subsumed by the overall umbrella of general cognitive ability, or *g*, as proposed by Cattell and Horn.

Currently, CHC theory describes approximately sixteen broad abilities and 80 narrow abilities. Nine of these broad abilities are represented on published assessment batteries, including, in alphabetical order, Auditory Processing (*Ga*), Crystallized Intelligence (*Gc*), Fluid Reasoning (*Gf*), Long Term Storage and Retrieval (*Glr*), Processing Speed (*Gs*), Quantitative Reasoning (*Gq*), Reading and Writing Ability (*Grw*), Working Memory (*Gwm*), and Visual Processing (*Gv*). Each broad ability is comprised of two or more narrow abilities, identified through factor analysis, that show strong, positive correlations to their superordinate broad ability. For example, the broad ability of Working Memory (*Gwm*) includes two distinct narrow abilities, Memory Span and Working Memory. These narrow abilities share convergent validity; they both correlate with Working Memory. They also demonstrate divergent validity; they are distinct enough from each other to represent separate characteristics of Working Memory.

Hierarchical models of intelligence have shifted the focus of intelligence testing in the field of psychology. Some psychologists emphasize how one performs across the various broad

abilities, rather than on overall g. By analyzing patterns of strengths and weaknesses in performance across the broad abilities and narrow abilities, these psychologists attempt to explain an individual's pattern of strengths and weaknesses within the broad scope of their intellectual functioning. Research is also beginning to identify correlations between the broad and narrow abilities and specific academic skills, so that a weakness in a specific broad or narrow ability can be associated with a weakness in real-life performance. For example, the broad ability of auditory processing and its associated narrow ability of phonetic coding are associated with the reading disorder dyslexia. Hierarchical theories and models of intelligence provide a systematic way to understand contemporary views of human intelligence and a foundation for continued research on human intelligence.

Further Reading

McGrew, K. S. (2009). CHC theory and the human cognitive abilities project: Standing on the shoulders of the giants of psychometric intelligence research. *Intelligence*, 37, 1-10.

Sattler, J. M. (2008). *Assessment of Children: Cognitive Foundations* (5th Ed.). LaMesa, CA: Jerome M. Sattler, Publisher.

W. J. Schneider & K. S. McGrew (2012). The Cattell-Horn-Carroll model of intelligence. In D. P. Flanagan & P. L. Harrison (Eds.), *Contemporary Intellectual Assessment: Theories, Tests and Issues*. New York, NY: The Guilford Press.