

# Spearman and the general factor of intelligence



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Since Spearman first suggested a general factor of intelligence (g) in 1904, many theorists have developed their own ideas about the nature of intelligence. Some agree on the existence of general intelligence, albeit the nature of g is hotly debated, and some disagree completely with the notion of g. The main theories to consider after Spearman's are multifactor theories and hierarchical theories. These are presently discussed along with some alternative theories, and the idea of a general factor of intelligence is explored.

Spearman (1904) used factor analysis on data from school children and found a positive correlation between their results in different tests of mental abilities. Following this finding, between 1904 and 1921 he used factor analysis on data from a variety of intelligence tests and found similar positive correlations (Maltby, Day & Macaskill, 2010). Spearman argued that this evidence suggests there is an overall g measured by these IQ tests. He described g as a kind of mental energy each individual possesses and believed it resulted in our specific abilities and skills (Maltby, et al.). If g was the only influence on intelligence the positive correlations would be perfect, which he noted was not the case. To explain this, Spearman suggested that each individual test has a specific ability (s) that is tapped, so performance on an arithmetic subtest, for example, depends partly on g and partly on numerical skills (s) specific to the test (Gleitman, 1995). It was argued by Thomson (1916) that Spearman's two-factor model is not the only way to account for the intercorrelational patterns observed in the data and that a theory comprising of many group factors could adequately replace Spearman's g in explaining the correlations. This argument has been

revisited recently by Bartholomew, Deary and Lawn (2009) who concluded that the apparent good fit of a model may not be sufficient to explain the workings of the brain during IQ tests. Despite apparent floors in Spearman's model, the notion of g has influenced many theorists since it was first proposed, with several theories having been developed in the wake of Spearman's work.

Multifactor theorists argue that there is more than one factor of intelligence to account for. They point out that many individuals display great skill and ability in one area, but poor ability in another (Sternberg & Kaufman, 1998). The first major theory after Spearman's pioneering work came from Thurstone, who saw Spearman's (1904) theory as limited by the idea that all variables had only one factor in common, g (Thurstone, 1934). Thurstone suggested that intelligence resulted from seven primary mental abilities, rather than these abilities resulting from g as Spearman suggested. The mental abilities proposed by Thurstone are; verbal comprehension, word fluency, number facility, spatial visualization, associative memory, perceptual speed and reasoning (Maltby, et al., 2010) and they are described by Thurstone (1924) as the primary abilities required for an individual to survive and thrive in one's environment. Cattell (1971), however, agreed with Spearman that g existed but took the notion a step further. He disagreed with Thurstone's model and pointed out the intercorrelation between the factors said to represent Thurstone's primary abilities. According to Cattell, these intercorrelations suggest the existence of an overall general factor. Unlike Spearman's theory of g, Cattell's model suggested that g was made up of two components; crystallised intelligence (Gc) and fluid intelligence (Gf).

Gc, refers to acquired knowledge and skills learned over the lifespan, whereas Gf refers to primary reasoning ability which is innate and which matures into adulthood. These two components are said to be distinct intelligences, but dynamically linked (Maltby, et al.). Humphreys (1967), however, does not believe Cattells model adequately explains intelligence and he points to methodological floors in Cattells study, for example, in the selection of variables. Humphreys also shows intercorrelations that fit Cattells model that fail to distinguish it from Vernons hierarchical model.

Similar to Thurstone (1934), Guilford developed a model of intelligence that disagreed with Spearmans g. He proposed the Structure of Intellect (SI) theory, which rejects the concept of g (Maltby, et al., 2010). SI states that there are three categories of intelligence, rather than one; operations, contents and products. There are five operations which are types of mental processing; evaluation, convergent production, divergent production, memory and cognition. There are five components which make up the mental material we possess on which operations are performed; visual, auditory, symbolic, semantic and behavioural. There are six products which consist of the form in which information is stored, processed and used; units, classes, relations, systems, transformations and implication. Each of these different elementary abilities from the three groups can combine in different ways to form the 150 abilities proposed by Guilford. For example, to remember a dog we would use the visual content and the unit product (Maltby, et al.). There has however been little support for Guilfords theory (Maltby, et al.).

Hierarchical theorists use the idea of Spearman's  $g$  but suggest  $g$  branches into more specific abilities (Maltby, et al., 2010). Both Vernon and Carroll suggest multiple levels of intelligence with group factors involved. The highest level in Vernons theory is  $g$ , which branches into two major group factors; verbal/education ( $v: ed$ ) and spatial/mechanical ( $k: m$ ) abilities. The next level contains minor group factors; verbal, numerical and educational abilities which stem from  $v: ed$ , and practical, mechanical, spatial and physical abilities which stem from  $k: m$ . These minor groups then branch into specific factors. A typical branch might go;  $g$   $v: ed$  educational abilities reading/spelling/use of grammar, for example (Maltby, et al.). Carroll based his work on 460 data sets obtained between 1927 and 1987 (Sternberg & Kaufman, 1998), describing intelligence using three hierarchical levels, termed stratum. Stratum I consists of 69 specific levels of intelligence, for example, spelling ability. Stratum II consists of eight group factors that branch from Stratum I. These are fluid, crystallised, memory and learning, visual, auditory, retrieval, cognitive speed and processing speed. Stratum III represents a single general level of intelligence, similar to Spearman's  $g$  (Sternberg & Kaufman). Carrolls theory incorporates Spearman's  $g$ , specific factors, Cattells  $G_c$  and  $G_f$ , Thurstones group factors and Vernons hierarchical approach (Maltby, et al.).

Gardner 's multiple intelligences theory challenges Spearman's  $g$  by suggested there are 9 completely distinct intelligences (Maltby, et al., 2010). He did not see intelligence as a learning mechanism or a way of working, but rather as a computer that works more or less well. According to Gardner's multiple intelligence theory, each intelligence resides in separate parts of the

brain but can interact and work together when needed (Maltby, et al.).

Gardner argues that the variety of different abilities and skill that humans display cannot be explained by  $g$  as measured by IQ tests (Visser, Ashton & Vernon, 2006). Evidence for this approach comes from studies of brain lesions, which may affect some abilities but not others (Gleitman, 1995). Savantism had also been used as evidence for multiple intelligences but this has now been refuted (Heaton & Wallace, 2004). Savants are persons who have one or more exceptional abilities that are unusual for their low level of general intelligence, however, the incidence of savantism is much lower than should be expected if intelligences are as independent as Gardner suggests (Gleitman) and it is now suggested that savantism reflects localised knowledge, rather than any form of intelligence (Heaton & Wallace).

Sternberg took a more cognitive approach than previous theorists in his Triarchic theory and identified three fundamental aspects of intelligence (Sternberg, 1985). These are in the form of three different sub-theories. The componential sub-theory refers to the mental processes through which intelligent behaviour is expressed. The contextual sub-theory describes how the mental processes adapt to, select and shape the environment to carry out actions. The experiential sub-theory describes how experience relates to intelligence in order to obtain new information (Maltby, et al., 2010).

The idea of a general factor of intelligence has much support, with Gottfredson (2003) arguing that theories rejecting a general intelligence such as Gardner's Multiple Intelligence theory and Sternberg's Triarchic theory cannot be correct because scores on intelligence tests that are said to

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measure  $g$  show a moderate correlation with income, performance in training and on the job, and can also predict ability to stay out of jail and stay alive. Castejon, Perez and Gilar (2010) point out that there is a significant lack of empirical evidence to support multiple intelligence theories.

There is much continued debate over the existence and nature of  $g$ . Whilst it can sometimes appear that we have multiple and independent intelligences by the way individuals often excel at a particular skill, there is a large body of evidence supporting the idea that intelligence does comprise a general factor of intelligence. The research since Spearman first proposed  $g$ , in particular Carroll's Stratum theory, suggests that the nature of  $g$  and its relationship to intelligence is more complex than Spearman first supposed, and whilst  $g$  may not be enough to explain intelligence by itself, it has withstood over 100 years of opposition and adaptation.