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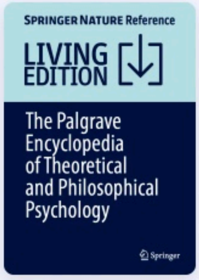

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Davide Serpico

Abstract

Intelligence is one of the most influential yet contested constructs in psychology. Psychometric research, beginning with early intelligence testing and the proposal of a general factor of intelligence, established influential models that continue to shape scientific and applied work. Yet competing theories, challenging the focus on abstract reasoning, highlight ongoing disputes about the nature of intelligence and the assessment of intellectual differences among individuals. Central debates concern the relationship between measurement and theory and the ontological status of the *g* factor—particularly whether intelligence is reducible to neurocognitive processes or must be treated as an emergent phenomenon. Contemporary research is marked by ontological and epistemological pluralism, reflecting divergent explanatory aims and practical needs. This pluralism also carries normative implications, as different conceptions of intelligence guide educational practices, inform policy, and shape broader societal understandings of human cognitive abilities.

Intelligence

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Abstract: Intelligence is one of the most influential yet contested constructs in psychology. Psychometric research, beginning with early intelligence testing and the proposal of a general factor of intelligence, established influential models that continue to shape scientific and applied work. Yet competing theories, challenging the focus on abstract reasoning, highlight ongoing disputes about the nature of intelligence and the assessment of intellectual differences among individuals. Central debates concern the relationship between measurement and theory and the ontological status of the *g* factor – particularly whether intelligence is reducible to neurocognitive processes or must be treated as an emergent phenomenon. Contemporary research is marked by ontological and epistemological pluralism, reflecting divergent explanatory aims and practical needs. This pluralism also carries normative implications, as different conceptions of intelligence guide educational practices, inform policy, and shape broader societal understandings of human cognitive abilities.

Keywords: General intelligence; *g* factor; Psychometrics; Factor analysis; Intelligence Quotient (IQ); Individual differences; Latent variables; Operationalism

1. Introduction

Few concepts in psychology are as widely used yet as difficult to define as intelligence. In ordinary language, this concept denotes a wide variety of abilities and traits: quick reasoning, learning capacity, adaptability to new situations, and problem-solving skills. Its meaning also varies across cultural and disciplinary contexts. This heterogeneity has led scientists to propose numerous definitions of intelligence: although common elements recur, such as abstract reasoning or the ability to learn, surveys conducted among psychologists, cognitive neuroscientists, and computer scientists collected dozens of formulations (Thorndike 1921; Legg & Hutter 2007).

Despite the centrality of this concept, the systematic study of intelligence has a relatively recent history. The main scientific characterisation of intelligence has been developed in psychometrics, the branch of differential psychology concerned with the assessment of individual differences in psychological traits. In this field, intelligence is conceptualised as a *latent variable* that is not directly observed but rather inferred from tests of intellectual abilities, such as Intelligence Quotient (IQ) tests. This approach attracted the most attention and became widely used in practical settings, such as educational and professional selection as well as clinical assessment of intellectual capacity (Neisser et al. 1996).

Historically, however, attempts to measure intelligence preceded attempts to define it: although the early developers of tests often held specific views about intelligence, their work was marked by a heavily pragmatic approach (Cianciolo & Sternberg 2004; Deary & Sternberg 2021; Lautrey 2002; Naglieri 2014; Pintner 1923). Robust theories of the nature of intelligence emerged later, mostly based on the work of Charles Spearman (1863-1945), who proposed the notion of the *general factor of intelligence* – also known as the *g* factor or simply *g*.

This conceptualisation has been influential in a variety of research areas. Behavioural genetics analyses the hereditary basis of individual differences in IQ (Knopik et al. 2017; Plomin & Deary 2015). The *g* factor has been investigated from an evolutionary perspective to attest its presence in other species (Burkart et al. 2017), as well as across sociocultural contexts to establish whether it is a universal human trait (Warne & Burningham 2019). The notion of general intelligence also inspired recent developments in Artificial General Intelligence and AI psychometrics (Goertzel 2014; Hernández-Orallo 2017). In the social sciences, IQ scores are regarded as strong predictors of variables of social interest such as academic and professional achievements, social status, health outcomes, and crime (Deary & Sternberg 2021; Jensen 1998; Gottfredson 1997; Haier 2017; Neisser et al. 1996). Finally, beyond individual-level correlates, IQ scores have also been used to chart population-level trends, most famously the steady generational increases in average IQ known as the 'Flynn effect' (Flynn 1987) and the more recent reversal in several countries (Bratsberg & Rogeberg 2018).

There are, however, important controversies on the *g* factor and its relationship with the notion of intelligence. Many scholars disagree about whether *g* can be understood as a single neurobiological process or a cognitive ability. The psychometric approach has also been criticised for focusing on a subset of human capacities – those typically prioritised in Western academic contexts – thus excluding aspects such as practical problem-solving and interpersonal skills from the science of intelligence (Gardner 1983; Goleman 1995; Sternberg 1985). Finally, the psychometric notion of intelligence is tied to debates on the *nature* and *nurture* of individual and group differences (Devlin et al. 1997; Eysenck & Kamin 1981; Rose et al. 1984; Snyderman & Rothman 1988). These controversies raise important questions on the theoretical fruitfulness, practical utility, and potential misuses of the concept of intelligence.

2. Background and Context

2.1 The Measurement of Intelligence

Early scientific studies of intelligence are commonly attributed to Francis Galton (1822-1911), who believed that greater intelligence is associated with more refined sensory discrimination and sensorimotor abilities. A similar approach was adopted by James Cattell (1860-1944), who developed tests concerning both physical and mental dimensions.

In the early 1900s, Alfred Binet (1857-1911) and Theodore Simon (1873-1961) developed a test to identify children in need of special educational programs, the *Binet-Simon scale*. Unlike Galton, they believed that intelligence could not be captured by measures of sensory discrimination, and therefore focused on tasks assessing attention, memory, and judgment. Their test assumed that children tend to become intellectually more competent with age, and a reliable test should thus reflect actual age-related differences. Children who exhibited 'levels of intelligence' below the average could be recommended for special education programs.

In the 1910s, William Stern (1871-1938) argued that the concept of level employed by Binet and Simon was inadequate for describing intellectual differences among children, and that mental age should be divided by chronological age. He proposed the term 'mental quotient' to designate the outcome of this calculation. The formula was later revised by Lewis Terman (1877-1956), who suggested multiplying the result of the ratio between mental and chronological age by one hundred, thereby eliminating decimals and inaugurating the index known as IQ. Terman also developed a revised version of Binet's test, known as the *Stanford-Binet scale*, which was adopted by Henry Goddard (1866-1957) to screen immigrants at the US borders and by Robert Yerkes (1876-1956) for army recruitment during the First World War (Greenwood 2014).

In the 1930s-1940s, David Wechsler (1896-1981) revised the methodology for calculating IQ, avoiding the connection between mental and chronological age. This new version, known as *deviation IQ*, became the standard in the field: raw test scores are converted to a scale in which the mean is 100 and the standard deviation is 15, and approximately 95% of the population has scores within two deviations. Notably, deviation IQ represents a measure of an individual's performance relative to their peers, rather than a 'universal' measure of intellectual abilities. Wechsler published two tests for IQ assessment that, after important revisions, are still used today: the *Wechsler Adult Intelligence Scale* (WAIS) was designed for individuals over the age of sixteen, while the *Wechsler Intelligence Scale for Children* (WISC) was intended for children.

Despite these technical advancements, mental tests lacked a robust theoretical framework for many years. Measurement innovations, in other words, were construed pragmatically before clarifying their ontology. The complex relationship between measurement and theory was the subject of intense debates.

2.2 The General Factor of Intelligence

Spearman (1904, 1923) provided the first theoretical basis for mental tests. He posited the existence of a *general factor of intelligence* to account for the empirical phenomenon known as the *positive manifold*: individuals who show good performance on a given intellectual task tend to perform well also on other tasks. In other words, cognitive performances are positively intercorrelated across cognitive domains, such as mathematical or linguistic. Spearman showed that, in this correlation structure, ~40% of variance in scores can be attributed to a general factor (Deary et al. 2010; Neisser et al. 1996).

To better contextualise Spearman's work, it is worth considering the original purpose of factor analysis and how Spearman adapted this technique to the study of intelligence. Galton (1883) first raised the question of how to reduce the number of anthropometric measures in large samples and simplify data interpretation. Francis Edgeworth (1893) contributed on the topic by calculating linear orthogonal functions of those variables, summarising information through fewer variables. Spearman then adopted this type of technique to identify a plausible theoretical connection between individual scores in different intelligence tests. Factor analysis thus assumed a *confirmatory* role, which several psychologists (Cattell 1952; Eysenck 1953; Thurstone 1947) considered attractive for its ability to ground theories in data. This shift in focus helped elucidate the psychological meaning of mental tests by suggesting behavioural constructs that could explain correlational data (Humphreys & Stark 2002). In this view, the single score produced by tests was thought to reflect a general ability, though imperfectly.

Although Spearman believed that specific abilities do not capture the 'essence' of intelligence (Cianciolo & Sternberg 2004), his theory involved various *s* factors intervening in specific tasks alongside *g* (Plucker & Shelton 2015). This idea was further developed by Godfrey Thomson (1939), who proposed that intelligence consists of many intellectual capabilities that operate simultaneously in task solving (Bartholomew et al. 2009; Humphreys 1979). In a similar vein, Louis Thurstone (1935, 1938) believed that *g* was a statistical artifact and developed an alternative version of factor analysis capable of better detecting specific factors – called Primary Mental Abilities, PMAs (Gould 1981; Willis et al. 2011).

These works paved the way for *hierarchical theories* of intelligence, many of which take *g* at the apex of a hierarchy – above various *s* factors – and provide the foundations for contemporary tests (Schneider & Flanagan 2015). Among them, the *Gf-Gc theory* (Cattell 1941) involves two main factors. Fluid ability (Gf) is defined as abstract reasoning and the ability to solve novel problems, and is often understood as a heritable, neurobiological potentiality. Crystallised ability (Gc), by contrast, is defined as the accumulation of knowledge and skills, and is thus highly dependent on education (Kaufman et al. 2013; Ortiz 2015). The correlations between *g* and fluid ability have led many to think of the latter as analogous to Spearman's *g* (Jensen 1998). A test often considered the best available measure of Gf is *Raven's Progressive Matrices*. Other hierarchical theories, such the *Verbal-perceptual model* (Vernon 1950), the *Extended Gf-Gc theory* (Horn & Cattell 1966), and the *Three-Stratum theory* (Carroll 1993), adopt several abilities alongside or below Spearman's *g* (Cianciolo & Sternberg 2004; Kaufman et al. 2013; Schneider & Flanagan 2015).

Although hierarchical theories involve multiple factors of intelligence, since Spearman's work a focus on *g* became the distinctive mark of the psychometric theory of intelligence. Debates on the ontological status of *g* intensified with the development of cognitive psychology.

2.3 Non-psychometric Theories of Intelligence

Non-psychometric theories reflect the belief that there are several types of cognitive abilities, only some of which can be captured by standard psychometric tests (Sternberg 2015). Their proponents do not dispute the positive manifolds but argue that to base a concept of intelligence on test scores alone overlooks many important aspects of mental ability (Neisser et al. 1996). Renowned examples are Howard Gardner's *Multiple Intelligences Theory* and Robert Sternberg's *Triarchic Theory*.

Inspired by Thurstone's work, Gardner (1983) argued that intelligence does not depend on a single mental capacity and proposed the existence of several intelligences: the first three represented those abilities recruited in IQ tests (linguistic, logical-mathematical, and visual-spatial intelligence); but the theory included intelligences divorced from the psychometric context – among them, musical, bodily-kinaesthetic, interpersonal, intrapersonal, and naturalistic intelligence. Gardner's identification of intelligence types was based on evidence from cognitive and clinical psychology. One of the criteria, for example, was the existence of cases where brain damage impairs a given intellectual behaviour, such as linguistic abilities, without affecting other domains, such as mathematical abilities.

The empirical adequacy of Gardner's theory has been questioned (Jensen 1998; Warne 2020), but its theoretical constructs have been relatively little analysed from an experimental standpoint – partly because there are limited standardised tests to evaluate the abilities it hypothesises (Shearer & Karanian 2017). Nevertheless, it has achieved great success in educational sciences for its capacity to capture individual specificities, supporting personalised learning strategies based on each person's strengths and weaknesses (Gardner et al. 2018).

The attempt to elaborate a broad-ranging description of intelligence also characterises Sternberg's *Triarchic Theory* – also known as the *Theory of Successful Intelligence*. Sternberg (1985) recognised the importance of analytical intelligence in test solving but emphasised that it is accompanied by two independent abilities of equal importance: creative and practical intelligence. Sternberg and colleagues have developed tests that assess the capacity for social interaction, managing stressful situations, and creative problem-solving, showing that they can predict variance in academic and professional achievement beyond what can be predicted by IQ measures alone (Nisbett et al. 2012).

One of Sternberg's main objectives was to highlight the importance of the sociocultural context, as the very meaning of intelligence varies depending on historical and geographical parameters. Even within a given society, different cognitive characteristics are emphasised across contexts, and these differences extend not just to conceptions of intelligence but also to what is considered adaptive in a broader sense (Serpell 1974; Sternberg 2004). These considerations have raised concerns about the possibility of evaluating intelligence without reference to its practical dimension (Naglieri & Goldstein 2015; Neisser et al. 1996).

Some non-psychometric theories of intelligence leveraged more recent advancements in cognitive psychology to provide a different basis for mental tests. Indeed, the early versions of many psychometric tests, such as the WAIS and the WISC, were developed well before theories of cognition reached full maturity and were themselves based on earlier tests like the Stanford-Binet. For instance, the developers of the *PASS Model* (Planning, Attention, Simultaneous, and Successive processing; Das et al. 1994; Naglieri & Das 2002) argued that the measurement of *g* is insufficient for examining children's specific cognitive problems. Similarly, the *Kaufman Assessment Battery for Children* (K-ABC; Kaufman et al. 2013) shifted the focus from the *content* of the items (e.g., verbal vs. nonverbal) to the *processes* that children use to solve problems (e.g., sequential vs. simultaneous).

Developments in cognitive psychology also fostered revisions to classical tests. For example, the WAIS was originally used to derive two IQ scores: one based on the verbal scale (Verbal IQ) and the other based on the non-verbal scale (Performance IQ); by combining all results, it was also possible to obtain an overall score (Full Scale IQ). Yet, recent versions of the scale allow one to derive multiple scores targeting specific cognitive domains, namely verbal comprehension, perceptual reasoning, working memory, and processing speed.

3. Debates and Challenges

3.1 The Neurocognitive Basis of *g*

Understood as a summary index of a correlation matrix, the *g* factor is relatively uncontroversial among scholars. Most debates lie in the neurocognitive interpretation of the positive manifold, that is, whether correlations among performances depend on a single neurocognitive process or on the concerted action of various aspects of the human neurocognitive architecture.

Scholars defending a generalist theory of intelligence have investigated the correlations between IQ scores and individual differences in several neurocognitive variables, trying to *reduce g* to one or more aspects of human cognition, biology, or physiology (Jensen 2002). This approach dates to Spearman himself, who described *g* as a form of 'mental energy.' If we found that a neurocognitive variable accounts for the *g* variance, the argument goes, we could identify the brain basis of *g*. Studies originating from this research program have found associations between IQ and brain size and efficiency, working memory, reaction time, attention, associative learning, glucose metabolic rates, and electrocortical activity, suggesting that these variables represent manifestations of *g* (Deary et al. 2010; Jensen 1998; Gray & Thompson 2004; Haier 2017).

For instance, processing speed is considered a promising variable to be investigated as individuals with higher IQ scores tend to respond faster on reaction-time and inspection-time paradigms. Speed is the core element of the *Minimal Cognitive Architecture Theory* (Anderson 2005), according to which problem solving is constrained by processing speed, and this would explain why cognitive abilities are intercorrelated – although the theory acknowledges the importance of domain-specific abilities alongside a central mechanism of information processing.

Other scholars are less optimistic regarding a potential reduction of *g* to neurocognitive variables. Kray and Frensch (2002) proposed various criteria for a successful reductive account of *g* and argued that none of them meets all the proposed criteria. In the case of processing speed, for example, alternative sources of individual differences cannot be excluded (Williams et al. 2008). Similar problems apply to working memory: scholars have proposed that memory predicts fluid intelligence not because memory *per se* is used to solve intelligence tests, but because tests indirectly measure individuals' resistance to interference (Gignac & Watkins 2015; Hasher et al. 2007; Kane et al. 2007). Moreover, working memory relates to multiple, independent sources of variance (i.e., different executive processes) and cannot be understood as a single cognitive process (Kovacs & Conway 2016).

Since most neurocognitive constructs show moderate correlations with *g*, recent theories of intelligence abandoned a commitment to *g* intended as a single process or ability, while acknowledging the generality of intelligence at the behavioural level.

3.2 Intelligence as an Emergent Phenomenon

Many cognitive psychologists understand intelligence as a global property of cognitive systems, rather than a single mental ability. In this view, complex cognitive systems consist of many modules or subsystems that process information independently of each other, often originating from independent evolutionary and developmental histories (Burkart et al. 2017; Garlick 2002; Ramus 2006). The attempt to bridge the gap between generalist and modular theories of mind has been the subject of extensive research (Pretz & Sternberg 2005).

Non-reductive and emergentist theories of general intelligence do not question the existence of 'psychometric *g*' but discard its interpretation as a neurocognitive construct. These theories have become the basis for network models of intelligence (Kan et al. 2019; Schmank et al. 2019).

A theory of this sort was proposed by Jacques Lautrey (2002), who considers *g* a developmental property. In this view, variables like processing speed affect all test performance but reflect global features of a neural system, realised by distinct aspects of the neurocognitive architecture and interacting with environmental factors (e.g., information processing improves with exercise). A similar theory is the *Mutualist Model* (Van der Maas et al. 2006), which recognises that the positive manifold is a robust empirical phenomenon but proposes an explanation involving the mutual relationship between cognitive processes: early in development, neurocognitive processes are uncorrelated but over time, the positive manifold emerges from beneficial interactions between these processes.

The *Parieto-Frontal Integration Theory* (Jung & Haier 2007; Haier 2017) holds that the neural basis of general intelligence is distributed throughout the brain, particularly in the parietal and frontal regions. In individuals with higher IQ scores, the brain tends to be more efficient when performing the same tasks – for example, it consumes less glucose than in people with lower scores. Intellectual differences may thus depend on different patterns of activation of the various brain areas involved. John Duncan (2010) proposed that a shared aspect among all cognitive performances resides in the capacity to integrate information from various cognitive modules, each of which processes and manipulates different types of information and performs distinct functions. The second key aspect of Duncan's theory is the cognitive system's capacity to divide complex problems into simpler sub-problems and then reassemble them to achieve a final solution.

Finally, the *Process Overlap Theory* (Kovacs & Conway 2016) accounts for the positive manifold as emerging from the overlap of different executive processes involved in item responses and working memory tasks. This theory is based on the finding that individuals with greater working memory capacity have better cognitive control, selective attention, and interference resolution. In contrast to the mutualist model, however, it suggests that interactions between processes occur when people solve mental tests rather than over ontogenesis.

3.3 Reflective and Formative Models in Psychometrics

A key theoretical disagreement underlying intelligence debates is whether constructs from factor analysis – whether Spearman's *g* factor or group factors – can be considered in 'realist' terms. It is somewhat natural to think that the constructs identified through factor analysis *exist* in some concrete sense (e.g., in causal or mechanistic terms), but many scholars highlight the limits of this interpretation (Gould 1981; Humphreys & Stark 2002; Serpico 2018; Van der Maas et al. 2014). Essentially, the bone of contention concerns whether factor analysis can help us formulate or confirm descriptive theories about the human cognitive architecture, or whether it can only reorganise the available data according to certain interpretative dimensions.

It is worth noting that the structure of hierarchical theories is suggested by correlational data rather than psychological or neuroscientific ones. When a population of individuals is administered a battery of tests, the mathematical structure of covariance forms a hierarchy: at the peak of the hierarchy there may be a general factor, which usually accounts for a large portion of the variance in test scores (Deary 2002; Nisbett et al. 2012). The lower levels of the hierarchy are organised around factors that account for smaller amounts of variance. Yet, variance is a characteristic of populations and therefore, factors are not to be interpreted on an individual level. This is highlighted by Borsboom et al. (2003), who explain that 'between-subject' variables cannot be understood as 'within-subject' variables: while the former represent sources of variability among individuals, the latter concern causal relationships between brain processes and behaviour.

In this view, questions about *g* concern its relevance, compared to other factors, to account for *individual differences* in test performance: hierarchical theories do not tell us that the *g* factor, at the top of the pyramid, *causally* influences all other cognitive abilities. Rather, they tell us that *g* accounts for a greater portion of scores variance, and it is in this sense that this factor is 'more general' than those in the lower strata. This focus on individual differences also explains the historical disconnection between psychometric theories and other branches of psychology, like developmental psychology, which focus on typical patterns of intellectual development (Piaget 1950).

Scholars describe this tension by distinguishing between *reflective* and *formative models* (Borsboom et al. 2003; Kovacs & Conway 2016, 2019; Van der Maas et al. 2014). In the former interpretation, factors are the *reflection of a latent variable*; this imposes a stance of entity realism regarding such variables, since the correlation between tests would depend on the causal influence of a given factor on test scores, correlations between tests, and individual differences between subjects or groups. In the latter interpretation, by contrast, the latent variable is a *result* rather than a *cause*. This interpretation is consistent with the view that the positive manifold emerges from the interaction between many cognitive and biological processes, without the involvement of a single general ability.

Although some scholars disagree about whether network theories of intelligence can efficiently account for tests data (McFarland 2020), emerging theories see factor analysis as a procedure to 'distil' the variance that different intellectual measures have in common, rather than to identify cognitive abilities and processes. Indeed, this technique does not provide unambiguous models of the cognitive architecture: for a given correlation matrix, there are many legitimate factor solutions (Haier et al. 2014; Hampshire et al. 2014).

4. Possibilities

Long used as a folk term, intelligence became a central construct in psychology and related fields beginning in the late nineteenth century, when psychometricians started to treat it as an object of systematic investigation through the development of intelligence testing. This tradition led to the influential construct of general intelligence (*g*), which has shaped much of the following research. Nevertheless, the fact that intelligence emerged from a folk category continues to underlie the plurality of approaches to its study and the ongoing debates about its nature, measurement, and significance.

To understand the strengths and limitations of the psychometric study of intelligence, it is important to keep in mind its pragmatic dimension: many advocates of this approach tend to value more the *utility* of a certain model rather than its *accuracy* in describing the structure of the human mind, defending *operative definitions* of intelligence (Eysenck & Kamin, 1981; Vessonen 2019; Wijsen et al. 2021). From this instrumentalist standpoint, the capacity of a test to measure a certain construct is often framed in terms of its *external validity* (Slaney 2017), which concerns the comparison between test performances and individual differences in other variables that are believed to be associated with intelligence (e.g., academic and professional success).

Many critics, however, see much circularity in defining intelligence in relation to tests. In this view, IQ tests are constructed precisely to predict academic success, and it is thus partly unsurprising that they exhibit external validity. Relying entirely on these correlations carries the risk of masking the psychological and socioeconomic reasons behind IQ's predictive success (Naglieri & Goldstein 2015; Neisser et al. 1996; Plucker & Shelton 2015; Richardson 1999; Urbina 2011).

Although there is not yet full consensus on the subject, controversies on the nature of intelligence have progressively redefined the domain of application of intelligence tests, leading many to recognise that the psychometric theory may not concern the concept of *intelligence in general*, but only the construct of *general intelligence*: while the first concept also includes aspects such as practical sense, emotional intelligence, and creativity, general intelligence mostly coincides with the specific ability involved in test solving. Also due to this reframing, research on intelligence is today characterised by a great degree of ontological and epistemological pluralism: different models of intelligence posit different entities, processes, or emergent phenomena as explanatory, and this often relates to diverging epistemic and practical objectives.

Given this connection between theory and practice, researchers are today less concerned with definitions of intelligence than with the practical use of tests. A pressing, open question regards the relationship between descriptive and normative aspects of the study of intelligence: each theory of intelligence embeds value judgments about which human capacities matter, which should be fostered, and which count as legitimate indicators of intelligence. A psychometric conception, emphasising abstract reasoning and test performance, comes with significant social implications. Historically, intelligence testing was mobilised in profoundly consequential ways, from immigration screening and military selection to eugenic policies, often legitimating forms of social stratification. Even today, the privileging of IQ in research and practice risks narrowing conceptions of human capability. Conversely, alternative theories of intelligence, while often criticised for lacking psychometric rigour, have influenced educational approaches that aim to recognise different learning styles, broaden the scope of valued abilities, and mitigate the exclusivity of test-based selection.

Pluralism in intelligence research, then, is not merely a reflection of scientific complexity but also a negotiation of values and practical priorities. In this sense, debates on intelligence exemplify broader questions in theoretical psychology about how psychological constructs should be understood when they are at once descriptive tools, predictive instruments, and vehicles of social values.

Cross References to other articles or articles in the Encyclopedia

- Artificial Intelligence; ID: 274699
- Child Development; ID: 274316
- Cognitive Psychology; ID: 279101
- Construct Validity; ID: 275660
- Creativity; ID: 279284
- Eugenics; ID: 280230
- Measurement; ID: 274775
- Nature-Nurture Debate; ID: 275729
- Operationalism; ID: 275768
- Psychometrics; ID: 274771
- Realism; ID: 275772
- Reductionism and Emergence; ID: 275349
- Validity; ID: 274070
- Values; ID: 278197
- Working Memory; ID: 286219

References

Anderson, M. (2005). Marrying intelligence and cognition. A Developmental View. In R. J. Sternberg & J. E. Pretz (Eds.), *Cognition and Intelligence* (pp. 268–287). Cambridge, UK: Cambridge University Press.

Bartholomew, D. J., Deary, I. J., & Lawn, M. (2009). A new lease of life for Thomson's bonds model of intelligence. *Psychological Review*, *116*(3), 567–579.

Borsboom, D., Mellenbergh, G. J., & Van Heerden, J. (2003). The theoretical status of latent variables. *PsychologicalRreview*, *110*(2), 203-219.

Bratsberg, B., & Rogeberg, O. (2018). Flynn effect and its reversal are both environmentally caused. *Proceedings of the National Academy of Sciences, 115*(26), 6674-6678.

Burkart, J.M., Schubiger, M.N., & van Schaik, C.P. (2017). The evolution of general intelligence. *Behavioral and Brain Sciences, 40,* 1-24.

Carroll, J. B. (1993). *Human cognitive abilities: A survey of factor-analytic studies*. Cambridge, UK: Cambridge University Press.

Cattell, R. B. (1941). Some theoretical issues in adult intelligence testing. *Psychological Bulletin, 38*(592).

Cattell, R. B. (1952). *Factor analysis: an introduction and manual for the psychologist and social scientist*. New York: Harper & Bros.

Cianciolo, A. T., & Sternberg, R. J. (2004). *Intelligence: A brief history*. John Wiley & Sons.

Das, J. P., Naglieri, J. A, & Kirby, J. R. (1994). *Assessment of cognitive process: The PASS theory of intelligence*. Boston: Allyn & Bacon.

Deary, I. J. (2002). *g* and cognitive elements of information processing: An agnostic view. In R. Sternberg & E. Grigorenko (Eds.), *The General Factor of Intelligence. How General is it?* (pp. 151–181). Mahwah: Lawrence Erlbaum.

Deary, I. J., & Sternberg, R. J. (2021). Ian Deary and Robert Sternberg answer five self-inflicted questions about human intelligence. *Intelligence*, *86*, 101539.

Deary, I. J., Penke, L., & Johnson, W. (2010). The neuroscience of human intelligence differences. *Nature Reviews Neuroscience*, *11*(3), 201-211.

Devlin, B., Fienberg, S. E., Resnik, D. P., & Roeder, K. (Eds.) (1998). *Intelligence, genes, and success: Scientists respond to The Bell Curve*. New York: Springer-Verlag Inc.

Duncan, J. (2020). *How intelligence happens*. Yale University Press.

Edgeworth, F. (1893). Statistical Correlation Between Social Phenomena. *Journal of the Royal Statistical Society, 56*(4), 670–675.

Eysenck, H. J. (1953). The logical basis of factor analysis. *American Psychologist*, *8*(3), 105–114.

Eysenck, H. J., & L. J. Kamin (1981). *Intelligence: The Battle for the Mind*. London: Palgrave Macmillan.

Flynn, J. R. (1987). "Massive IQ gains in 14 nations: What IQ tests really measure." *Psychological Bulletin, 101*(2), 171–191.

Galton, F. (1883). *Inquiry into human faculty and its development*. London: MacMillan.

Gardner, H. (1983). *Frames of mind: The theory of multiple intelligences*. New York: Basic books.

Gardner, H., Kornhaber, M., & Chen, J. (2018). The theory of multiple intelligences: Psychological and educational perspectives. In R.J. Sternberg (Ed.), *The Nature of Human Intelligence* (pp. 116–129), Cambridge, MA: Cambridge University Press.

Garlick, D. (2002). Understanding the nature of the general factor of intelligence: The role of individual differences in neural plasticity as an explanatory mechanism. *Psychological Review, 109*, 116–136.

Gignac, G. E., & Watkins, M. W. (2015). There may be nothing special about the association between working memory capacity and fluid intelligence. *Intelligence*, *52*, 18–23.

Goertzel, B. (2014). Artificial general intelligence: concept, state of the art, and future prospects. *Journal of Artificial General Intelligence, 5*(1), 1-48.

Goleman, D. (1995). *Emotional intelligence.* Bantam Books, Inc.

Gottfredson, L. S. (1997). Why *g* matters: The complexity of everyday life. *Intelligence*, *24*(1), 79-132.

Gould, S. J. (1996). *The mismeasure of man*. New York: Norton & Co.

Gray, J. R., & Thompson, P. M. (2004). Neurobiology of intelligence: science and ethics. *Nature reviews. Neuroscience*, *5*(6), 471–482.

Greenwood, J. D. (2014). Intelligence defined: Wundt, James, Cattell, Thorndike, Goddard, and Yerkes. In *Handbook of Intelligence: Evolutionary theory, historical perspective, and current concepts* (pp. 123–135). New York, NY: Springer New York.

Haier, R. J. (2017). *The neuroscience of intelligence*. Cambridge University Press.

Haier, R. J., Karama, S., Colom, R., et al. (2014). A comment on "fractionating intelligence" and the peer review process. *Intelligence*, *46*, 323–332.

Hampshire, A., Highfield, R. R., Parkin, B. L., & Owen, A. M. (2012). Fractionating human intelligence. *Neuron*, *76*(6), 1225–1237.

Hasher, L., Lustig, C., & Zacks, R. (2007). Inhibitory mechanisms and the control of attention. In A. R. A. Conway, C. Jarrold, M. J. Kane, A. Miyake & J. Towse (Eds.), *Variation in working memory* (pp. 227–249). New York: Oxford University Press.

Hernández-Orallo, J. (2017). *The measure of all minds: evaluating natural and artificial intelligence*. Cambridge University Press.

Horn, J. L., & Cattell, R. B. (1966). Refinement and test of the theory of fluid and crystallized general intelligences. *Journal of Educational Psychology, 57,* 253–270.

Humphreys, L. G. (1979). The construct of general intelligence. *Intelligence*, *3*(2), 105-120.

Humphreys, L. G., & Stark, S. (2002). General Intelligence: Measurement, Correlates, and Interpretations of the Cultural-Genetic Construct. In R. Sternberg & E. Grigorenko (Eds.), *The General Factor of Intelligence. How General is it?* (pp. 87–116). Mahwah: Lawrence Erlbaum.

Jensen, A. R. (1998). *The g factor: The science of mental abilily*. New York: Praeger.

Jensen, A. R. (2002). Psychometric g: Definition and Substantiation. In R. Sternberg & E. Grigorenko (Eds.), *The General Factor of Intelligence. How General is it?* (pp. 39–54). Mahwah: Lawrence Erlbaum.

Jung, R. E., & Haier, R. J. (2007). The Parieto-Frontal Integration Theory (P-FIT) of intelligence: converging neuroimaging evidence. *Behavioral and Brain Sciences*, *30*(2), 135–154.

Kan, K. J., van der Maas, H. L. J., & Levine, S. Z. (2019). Extending psychometric network analysis: Empirical evidence against *g* in favor of mutualism?. *Intelligence, 73*, 52–62.

Kane, M. J., Conway, A. R. A., Hambrick, D. Z., & Engle, R. W. (2007). Variation in working memory capacity as variation in executive attention and control. In A. R. Conway, C. Jarrold, M. J. Kane, A. Miyake & J. Towse (Eds.), *Variation in working memory* (pp. 21–48). New York: Oxford University Press.

Kaufman, J. C., Kaufman, S. B., & Plucker, J. A. (2013). Contemporary theories of intelligence. In D. Reisberg (Ed.), *The Oxford Handbook of Cognitive Psychology* (pp. 811–822). New York: Oxford University Press.

Knopik, V. S., Neiderhiser, J. M., DeFries, J. C., & Plomin, R. (2017). *Behavioral genetics* (pp. p93-110). New York: Worth Publishers, Macmillan Learning.

Kovacs, K., & Conway, A. R. (2016). Process overlap theory: A unified account of the general factor of intelligence. *Psychological Inquiry*, *27*(3), 151-177.

Kovacs, K., & Conway, A. R. (2019). What is IQ? Life beyond "general intelligence". *Current Directions in Psychological Science*, *28*(2), 189-194.

Kray, J., & Frensch, P. (2002). A View From Cognitive Psychology: *g*–(G)host in the Correlation Matrix? In R. Sternberg & E. Grigorenko (Eds.), *The General Factor of Intelligence. How General is it?* (pp. 183–220). Mahwah: Lawrence Erlbaum.

Lautrey, J. (2002). Is there a general factor of cognitive development?. In R. Sternberg & E. Grigorenko (Eds.), *The General Factor of Intelligence. How General is it?* (pp. 117–148). Mahwah: Lawrence Erlbaum.

Legg, S., & Hutter, M. (2007). A collection of definitions of intelligence. *Frontiers in Artificial Intelligence and applications, 157*, 17.

McFarland, D. (2020). The effects of using partial or uncorrected correlation matrices when comparing network and latent variable models. *Journal of Intelligence*, *8*(1), 7.

Naglieri, J. A. (2014). Hundred years of intelligence testing: Moving from traditional IQ to second-generation intelligence tests. In S. Goldstein, D. Princiotta, & J. A. Naglieri (Eds.), *Handbook of intelligence: Evolutionary theory, historical perspective, and current concepts* (pp. 295–316). New York, NY: Springer New York.

Naglieri, J. A., & Das, J. P. (2002). Practical Implications of General Intelligence and PASS Cognitive Processes. In R. Sternberg & E. Grigorenko (Eds.), *The General Factor of Intelligence. How General is it?* (pp. 55–84). Mahwah: Lawrence Erlbaum.

Naglieri, J. A., & Goldstein, S. (2014). Closing Comments: Intelligence and Intelligence Tests–Past, Present, and Future. In S. Goldstein, D. Princiotta, & J. A. Naglieri (Eds.), *Handbook of intelligence: evolutionary theory, historical perspective, and current concepts* (pp. 487-490). New York, NY: Springer New York.

Neisser, U., Boodoo, G., Bouchard Jr, T. J., Boykin, A. W., Brody, N., Ceci, S. J., ... & Urbina, S. (1996). Intelligence: knowns and unknowns. *American Psychologist*, *51*(2), 77.

Nisbett, R. E., Aronson, J., Blair, C., Dickens, W., Flynn, J., Halpern, D. F., & Turkheimer, E. (2012). Intelligence: new findings and theoretical developments. *American Psychologist*, *67*(2), 130.

Ortiz, S. O. (2015). CHC theory of intelligence. In S. Goldstein, D. Princiotta, & J. A. Naglieri (Eds.), *Handbook of Intelligence. Evolutionary Theory, Historical Perspective and Current Concepts* (pp. 209–227). New York: Springer.

Piaget, J. (1950). *The psychology of intelligence*. Routledge.

Pintner, R. (1923). *Intelligence testing*. New York: Henry Holt.

Plomin, R., & Deary, I. J. (2015). Genetics and intelligence differences: five special findings. *Molecular psychiatry*, *20*(1), 98–108.

Plucker, J. A., & Shelton, A. L. (2015). General intelligence (g): Overview of a complex construct and its implications for genetics research. *Hastings Center Report*, *45*(S1), S21-S24.

Pretz, J. E., & Sternberg, R. J. (2005). Unifying the Field: Cognition and Intelligence. In R. J. Sternberg & J. E. Pretz (Eds.), *Cognition and Intelligence* (pp. 306–318). Cambridge, UK: Cambridge University Press.

Ramus, F. (2006). Genes, brain, and cognition: A roadmap for the cognitive scientist. *Cognition*, *101*(2), 247–269.

Richardson, K. (1999). *The Making of Intelligence*. New York: Columbia University Press.

Rose, S, L. J. Kamin, & R. C. Lewontin (1984). *Not in Our Genes: Biology, Ideology and Human Nature*. New York: Pantheon Books.

Schmank, C. J., Goring, S. A., Kovacs, K., & Conway, A. R. (2019). Psychometric network analysis of the Hungarian WAIS. *Journal of Intelligence*, *7*(3), 21.

Schneider, W. J., & Flanagan, D. P. (2015). The relationship between theories of intelligence and intelligence tests. In S. Goldstein, D. Princiotta & J. A. Naglieri (Eds.), *Handbook of Intelligence. Evolutionary Theory, Historical Perspective and Current Concepts* (pp. 317–340). New York: Springer.

Serpell, R. (1974). Aspects of intelligence in a developing country. *African Social Research, 17*, 578-596.

Serpico, D. (2018). What kind of kind is intelligence?. *Philosophical Psychology, 31*(2), 232-252.

Shearer, C. B., & Karanian, J. M. (2017). The neuroscience of intelligence: Empirical support for the theory of multiple intelligences?. *Trends in neuroscience and education*, *6*, 211-223.

Slaney, K. (2017). *Validating psychological constructs: Historical, philosophical, and practical dimensions*. Springer.

Snyderman, M., & Rothman, S. (1988). *The IQ Controversy, the Media and Public Policy*. New Brunswick, NJ: Transaction Publisher.

Spearman, C. (1904). 'General Intelligence', Objectively Determined and Measured. *The American Journal of Psychology*, *15*(2), 201–292.

Spearman, C. (1923). *The Nature of Intelligence and the principles of cognition*. London: MacMillan.

Sternberg, R. J. (1985). *Beyond IQ: A triarchic theory of human intelligence*. CUP Archive.

Sternberg, R. J. (2004). Culture and intelligence. *American psychologist*, *59*(5), 325.

Sternberg, R. J. (2015). Multiple intelligences in the new age of thinking. In S. Goldstein, D. Princiotta & J. A. Naglieri (Eds.), *Handbook of Intelligence. Evolutionary Theory, Historical Perspective and Current Concepts* (pp. 229–241). New York: Springer.

Thomson, G. H. (1939). *The factorial analysis of human ability*. London: University of London Press.

Thorndike, E. L. (1921). Intelligence and its measurement: A symposium—I. *Journal of Educational psychology, 12*(3), 124.

Thurstone, L. L. (1935). *The Vectors of Mind. Multiple-Factor Analysis for the Isolation of Primary Traits*. Chicago: University of Chicago Press.

Thurstone, L. L. (1938). *Primary Mental Abilities*. Chicago: University of Chicago Press.

Urbina, S. (2011). Tests of intelligence. In R.J. Sternberg & S.B. Kaufman (Eds.), *The Cambridge Handbook of Intelligence* (pp. 20–38). Cambridge, MA: Cambridge University Press.

Van der Maas, H. J. L., Dolan, C. V., Grasman, R. P. P. P., et al. (2006). A dynamical model of general intelligence: the positive manifold of intelligence by mutualism. *Psychological Review, 113*(4), 842–861.

Van der Maas, H. J. L., Kan, K. J., & Borsboom, D. (2014). Intelligence Is What the Intelligence Test Measure. Seriously. *Journal of Intelligence, 2*, 12–15.

Vernon, P. E. (1950). *The Structure of Human Abilities, 2nd edition.* London, UK: Methuen, 1961.

Vessonen, E. (2019). Operationalism and realism in psychometrics. *Philosophy Compass, 14*(e12624), 1-13.

Warne, R. T. (2020). *In the know: Debunking 35 myths about human intelligence*. Cambridge University Press.

Warne, R.T. & Burningham, C. (2019). Spearman's *g* found in 31 non-Western nations: Strong evidence that *g* is a universal phenomenon. *Psychological Bulletin, 145*(3), 237-272.

Wijsen, L. D., Borsboom, D., & Alexandrova, A. (2021). Values in Psychometrics. *Perspectives on Psychological Science*, *17(3)*, 788-804.

Williams, B., Myerson, J., & Hale, S. (2008). Individual differences, intelligence, and behavior analysis. *Journal of the Experimental Analysis of Behavior*, *90*(2), 219–231.

Willis, J. O., Dumont, R., & Kaufman, A. S. (2011). Factor-analytic models of intelligence. In R. J. Sternberg & S. B. Kaufman (Eds.), *The Cambridge Handbook of Intelligence* (39–57), Cambridge (MA), Cambridge University Press.