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## Intelligence: What is it?

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Intelligence matters to us. In surveys people rank it second only to good health. Women worldwide believe smarter men make better husband material. Entrepreneurs hawk brain-boosting games, foods, supplements and training programmes. And the media quickly broadcast any scientific study claiming to discover how we can make ourselves, or our children, smarter. Yet our keen private interest in intelligence is matched by a reluctance to acknowledge publicly that some people have more of it than others. Democratic people value social equality above all, so they mistrust anything that might generate or justify inequality - but intelligence is no more equally distributed in human populations than height

is. This tension has led to rancorous controversy over intelligence and intelligence testing but it has also benefited the science by pushing it exceedingly hard. A century of clashes and stunning discoveries has upended assumptions and revealed some fascinating paradoxes. Intelligence is definitely not what most of us had imagined.

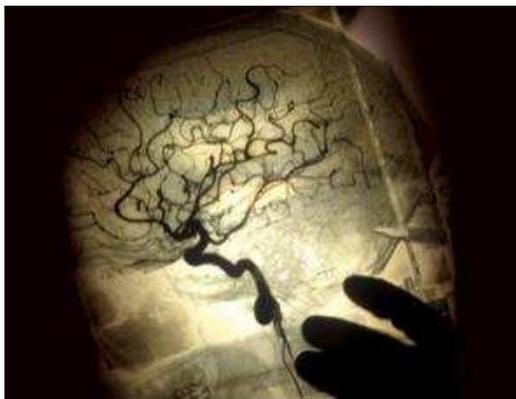
### Different types of intelligence

Consider the engineer's superior spatial intelligence and the lawyer's command of words and you have to wonder whether there are different types of intelligence. This question was debated ferociously during the early decades of the 20th century. Charles Spearman, on one side, defended the omnipotence of his general factor of intelligence, *g*. On the other, Louis Thurstone argued for seven "primary abilities", including verbal comprehension (in which females excel) and spatial visualisation (in which males excel). Thurstone eventually conceded that all his primary abilities were suffused with the same *g* factor, while Spearman came to accept that there are multiple subsidiary abilities in addition to *g* on which individuals differ.

This one-plus-many resolution was not widely accepted until 1993, however. It was then that American psychologist John B. Carroll published his "three stratum theory" based on a monumental reanalysis of all factor analysis studies of intelligence ([see diagram](#)). At the top is a single universal ability, *g*. Below this indivisible *g* are eight broad abilities, all composed mostly of *g* but each also containing a different "additive" that boosts performance in some broad domain such as visual perception or processing speed. These in turn contribute to dozens of narrower abilities, each a complex composite of *g*, plus additives from the second level, together with life experiences and specialised aptitudes such as spatial scanning.

This structure makes sense of the many differences in ability between individuals without contradicting the dominance of *g*. For example, an excellent engineer might have exceptional visuospatial perception together with training to develop specialist abilities, but above all a high standing on the *g* factor. The one-plus-many idea also exposes the implausibility of multiple-intelligence theories eagerly adopted by educators in the 1980s, which claimed that by tailoring lessons to suit the individual's specific strength - visual, tactile or whatever - all children can be highly intelligent in some way.

### Quantifying intelligence



Some have more than others, but what is it? (Image: Joe McNally/Getty)

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The first intelligence quotient (IQ) test was born of a desire to help the most vulnerable. In 1904 the French Ministry of Education commissioned psychologist Alfred Binet to find a practical way to identify children who would fail elementary school without special help. Binet assembled 30 short, objective questions on tasks such as naming an everyday object and identifying the heavier of two items. A child's performance on these, he believed, would indicate whether their learning was "retarded" relative to their peers. His invention worked and its success spawned massive intelligence-testing programmes on both sides of the Atlantic. Organisations turned to IQ tests to screen large pools of applicants: military recruits for trainability, college applicants for academic potential and job applicants for employability and promotability. The tests were eagerly adopted at first as a way to select talent from all social levels, but today their use can be considered contentious, partly because they do not find equal amounts of intelligence everywhere.

Nevertheless, intelligence testing continues because it has practical value. Many colleges, employers and the armed services still use paper-and-pencil or computer-based intelligence tests to screen large groups of applicants. The gold standard, however, is the orally administered, one-on-one IQ test, which requires little or no reading and writing. These include the Stanford-Binet and Wechsler tests, which take between 30 and 90 minutes and combine scores from areas such as comprehension, vocabulary and reasoning to give an overall IQ. These batteries are used to diagnose, treat or counsel children and adults who need personal or academic assistance. Ability testing is governed by detailed ethical standards and professionally administered tests must meet strict criteria including lack of cultural bias and periodic updating. In fact, IQ tests are the most technically sophisticated of all psychological tests and undergo the most extensive quality checks before publication.

### What do IQ tests measure?

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A century ago, British psychologist Charles Spearman observed that individuals who do well on one mental test tend to do well on all of them, no matter how different the tests' aims, format or content. So, for example, your performance on a test of verbal ability predicts your score on one of mathematical aptitude, and vice versa. Spearman reasoned that all tests must therefore tap into some deeper, general ability and he invented a statistical method called factor analysis to extract this common factor from the web of positive correlations among tests. This showed that tests mostly measure the very same thing, which he labelled the general factor of intelligence or "g factor". In essence, g equates to an individual's ability to deal with cognitive complexity.

Spearman's discovery lay neglected in the US until the 1970s, when psychologist Arthur Jensen began systematically testing competing ideas about g. Might g be a mere artefact of factor analysis? No, it lines up with diverse features of the brain, from relative size to processing speed. Might g be a cultural artefact, just reflecting the way people think in western societies? No, in all human groups - and in other species too - most cognitive variation comes from variation in g.

Jensen's analyses transformed the study of intelligence, but while the existence of g is now generally accepted, it is still difficult to pin down. Like gravity, we cannot observe it directly, so must understand it from its effects. At the behavioural level, g operates as an indivisible force - a proficiency at mentally manipulating information, which undergirds learning, reasoning, and spotting and solving problems in any domain. At the physiological level, differences in g probably reflect differences in the brain's overall efficiency or integrity. The genetic roots of g are even more dispersed, probably emerging from the joint actions of hundreds if not thousands of genes, themselves responding to different environments.

Higher g is a useful tool, but not a virtue. It is especially handy when life tasks are complex, as they often are in school and work. It is also broadly protective of health and well-being, being associated with lower rates of health-damaging behaviour, chronic illness, post-traumatic stress disorder, Alzheimer's and premature death.

Higher g helps an individual get ahead socioeconomically but it has little connection with emotional well-being or happiness. Neither does it correlate with conscientiousness, which is a big factor in whether someone fulfils their intellectual potential.

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