

Models and Theories of Intelligence

[See online here](#)

The topic intelligence has inspired any different beliefs, myths and theories, yet still to date, there is no universal definition of intelligence. Here, you will read about how the abstract topic of intelligence can be made concrete and measurable, about which models of intelligence were developed and which tests are used by medical practitioners.



What is Intelligence?

There is still no standardized scientific definition for the term 'intelligence'. W. Stern (1911), a pioneer in the field of intelligence, defined intelligence as the 'general capacity of an individual to consciously adjust his thinking to new requirements'. Intelligence is a **hypothetical construct** that can only be observed in behavior. Read here about methodological basics.

The term intelligence comprises verbal and mathematical abilities as well as logical reasoning.

Note: Creativity and emotional intelligence are not included in the term intelligence. Cognitive flexibility comprises 2 pillars:

- Acquiring knowledge
- Adapting to changing circumstances

Intelligence Quotient

The classical IQ by Binet and Stern



[Image:](#) Alfredo Benet Junior (July 11, 1857 - October 18, 1911). License: Public Domain

Binet was one of the first persons that attempted to make intelligence measurable. At the beginning of the 20th century, he was commissioned to develop an **intelligence test** to measure the intellectual capacity of school children. The goal of the test was to identify children with learning disabilities in order to provide them with special individualized help.

The level of difficulty of the test was scaled in ascending order and was supposed to assess the intellectual age of a child with tasks usually passed by 6-year-olds, 7-year-olds, etc.

Based on Binet's work, **Stern** developed the classic **intelligence quotient (IQ)**, which is, however, not applicable to adults.

$$\text{IQ} = (\text{mental age} / \text{chronological age}) \times 100$$

Example: John is 9 years old and solves all the tasks for 11-year-old children $\rightarrow (11/9) \times 100 = 122.2$

The deviation IQ by Wechsler

David Wechsler later developed as an alternative—the **deviation IQ**, which is still the most common type of intelligence measurement today. The subject's score on the intelligence test is compared to the average IQ of people of the same age (the average is standardized to 100 points).

The quotient reflects the subject's relative position within the selected reference group (e.g., high school students, children in special schools of the same age). Scores obtained from different reference groups are not directly comparable. One similarity between the deviation IQ and the classic IQ is that both compare the test performance with the

respective age group.

The 4 Most Important Models of Intelligence

Important terms on models of intelligence

- **Factor analysis:** In factor analysis, the **correlation of the individual tasks of an intelligence test** is calculated. Tasks with closely related topics represent their content on a higher level. Example: Tasks that demand spatial sense correlate with each other to such a degree that they can be summarized as the spatial factor.
- **Extraction:** Possibilities of generating factors

Two-factor theory by Spearman (1904): the *g* factor

Spearman observed that subjects who were able to easily solve intelligence tasks (calculating) also scored high on other tasks (picture arrangements). From this, he concluded that there must be an inherent cognitive ability.

This intelligence is active in the performance of any task, independent of the type of task. Spearman called this basic ability the **general factor of intelligence—the *g* factor**. In hierarchical terms, this *g* factor is placed above the *s* factors.

For **specific intelligence performances, *s* factors** are necessary. Spearman argued that these *s* factors do not correlate with each other, meaning that an individual does not necessarily have to perform well or badly in multiple specific areas.

- ***g* factor** determines: processing speed, mental capacity, or intellectual performance ('genius' or 'simple character?')
- ***s* factors** determine: spatial, numerical, verbal, and mechanical abilities for specific areas



© 2015 Lecturio

Image: S-factors. By: Lecturio

Multiple-factor theory of intelligence by Thurstone (1938)

Thurstone opposed Spearman's idea of a superordinate general intelligence factor. Instead, he developed a **multiple-factor theory** of intelligence that established **7 primary factors**. These primary factors are all on the same level.

Thurstone's 7 primary mental abilities include:

- Number facility
- Verbal comprehension
- Word fluency
- Spatial visualization
- Associative memory
- Reasoning
- Perceptual speed

Berlin Model of Intelligence Structure (BIS) by Jäger (1984)

In German-speaking countries, intelligence research was strongly influenced by Jäger's descriptive model which can be divided into 2 modalities: **operational abilities** and **content-related abilities**. Like Spearman, Jäger assumed a superior **general factor g**. The Berlin Model of Intelligence Structure (BIS) is derived directly from Jäger's model.

g factor	
4 Operational abilities	3 Content-related abilities
Memory: active memorization and short-term or medium-term recall or reproduction	Verbal thinking: degree of acquirement and availability of verbal material
Creativity: fluid, flexible, inventive production of ideas	Figural thinking: figural, pictographic
Processing capacity: ease of processing complex information and concentration	Numerical thinking: degree of acquirement and availability of numerical material
Processing speed: speed of operation, speed at which information is processed	

Model of fluid and crystallized intelligence by Cattell (1971)

Fluid intelligence is the native ability to handle new situations and to solve problems without utilizing previously acquired knowledge. Fluid intelligence is independent of culture and develops during childhood.

Crystallized intelligence describes acquired knowledge. This knowledge is culture-specific with respect to knowledge contents and possible experiences. Crystallized intelligence peaks during adolescence and usually remains constant even in old age.

Note: Crystallized intelligence is retained in old age; fluid intelligence continuously decreases from adolescence onwards.

Changes in Intelligence

The proportion of older people in the population is continually increasing and understanding the development of intelligence in old age is becoming a focus of medicine and research. Old people notably differ in their degree of cognitive abilities. For the most part, training, not age, is crucial.

Average values regarding the development of intelligence:

- Until the age of 75: Minor changes
- Afterward: Accelerated degradation of cognitive functions

Measuring Intelligence: Intelligence Tests

Intelligence tests are psychological methods for **assessing cognitive performances** or intelligence, which is characterized as IQ. These tests are always standardized to a group, meaning that the results of the tests have a normal distribution in a certain population and the result of an individual is always a comparison with other individuals within this group.

Wechsler Intelligence Scale (WIS)

To date, the Wechsler Intelligence Scale for Children (WISC) and adults (WAIS), developed by the psychologist David Wechsler, is the most commonly used intelligence test. It is based on the general factor by Spearman and is broadly divided into a **verbal subtest** and a **performance subtest**. Accordingly, a **verbal IQ** and a **performance IQ** are calculated; their mean makes the **full-scale IQ**.

The different subtests test for:

Verbal part	Action part
<ul style="list-style-type: none">• Information• Vocabulary test<ul style="list-style-type: none">• Digit span• Comprehension• Arithmetic thinking• Finding similarities	<ul style="list-style-type: none">• Matrix reasoning• Picture concepts<ul style="list-style-type: none">• Mosaic test• Block design• Letter-number sequencing

The test is suitable for **assessing the general cognitive state of development** and for the examination of age-, environment-, or disease-related performance **impairments** in specific areas.

WIS represents an individual test where a subject is tested by an examiner. The test takes about 60–90 minutes. In order to ensure the **objectivity** of the administration, the examiner follows highly standardized instructions. Furthermore, WIS expresses a culture-independent assessment of intelligence.

Note: General knowledge (i.e., ‘information’) and vocabulary of the WIS are standardized to specific groups who lived and grew up in specific countries and received a specific education (e.g., the WISC-IV US standardization sample consisted of 2,200 children between the ages of 6 and 16 years). Hence, the test must consistently be revised in order to exclude obsolete questions and wordings.

Analysis of WIS

The **mean** WIS score is 100 points, the **standard deviation** is 15 points, and its design precludes gender differences. Furthermore, there are versions for adults, school children,

and preschool children. The IQ is taken from the averaged verbal and performance subtests.

Examples of tasks included in WIS

Verbal subtest:

- **Information:** What is the capital of France?
- **Comprehension:** What do you do if you find an injured person lying on the sidewalk?
- **Arithmetic:** John bought 3 books for 5 dollars each, and paid a 10% sales tax. How much did he pay altogether?
- **Similarities:** How are a snake and an alligator alike?
- **Digit span:** The subject hears a number string once (e.g. 7 4 9 7 2) and has to verbally repeat it forward or backward.
- **Vocabulary:** What is the meaning of the word 'articulate'?

Performance subtest:

- **Digit-symbol coding:** The subject receives a code that should help to assign specific symbols to specific numbers (e.g. 1, 2, 3, 4).
- **Picture completion:** In a displayed picture, the subject has to name what is missing in the depiction (e.g. ox without horns)
- **Block design:** Specific displayed patterns must be reconstructed with cubes.
- **Picture arrangement:** A quantity of jumbled up pictures (e.g. comics) have to be arranged in chronological order so that they make up an intelligible story.
- **Object assembly:** The subject has to assemble a known object from a certain quantity of pieces of a puzzle.

Intelligence Structure Test (IST)

The **Intelligence Structure Test (IST)** is based on the multiple-factor theory by Thurstone and is designed to be a group test that can be taken individually. It comprises **verbal, pictorial, and numerical** subtests; a newer version of IST 2000 also tests for memory. From the verbal, pictorial, and numerical factors, a secondary factor—**reasoning** is calculated. The administration of IST lasts around 90 minutes and can be taken by pen and paper or on the computer.

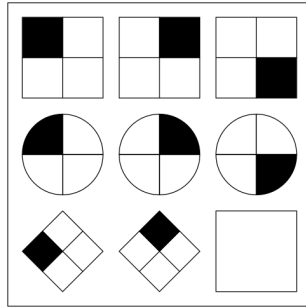
The **objectivity** of IST is very high because the subjects work individually without the interference of an examiner.

The mean IST score is 100 points and the standard deviation is 10 points. An **overall IQ** cannot be determined from IST; it only yields values for the separate subtests.

Culture fair test

The culture fair test is based on Cattell's model of **crystallized and fluid intelligence**. The test assesses culture-independent fluid intelligence. It consists of the 4 nonverbal subtests—series, classifications, matrices, and conditions.

Progressive matrices test by Raven (1936)



[Image](#): Raven's progressive matrices example. By: Lifeof Riley. License: [CC BY-SA 3.0](#)

The progressive matrices test by **Raven** is a **nonverbal multiple-choice intelligence test**. During World War II, every draftee underwent the progressive matrices test, independent of literacy. The tasks of the test are based on understanding a present pattern and selecting the missing piece from a series of several provided pieces. There are 3 different types of matrices: **standard, colored, and advanced matrices**.

In 2007, 2 studies concluded that people with **Asperger syndrome** or **classic autism** achieve higher scores on average on the progressive matrices test than on WIS.

Intelligence and Achievement

The reason for assessments of intelligence is associated with the prediction of achievement variables: achievement in school, at work, in academics, etc. Students are divided into 2 groups, according to their achievements and intelligence:

- Underachiever: Achievement is not as high as expected (frequent cause: motivational deficits).
- Overachiever: Achievement is higher than expected (frequent cause: high conformity, ambition, and effort).

Excursus: The Dunning-Kruger Effect

'If you're incompetent, you can't know you're incompetent ... [T]he skills you need to produce a right answer are exactly the skills you need to recognize what a right answer is.' (David Dunning)

In their studies, Dunning and Kruger were able to identify certain characteristics that are typically found in individuals who are unconsciously incompetent.

Incompetent people:

- Overestimate their own abilities and skills
- Fail to recognize their own lack of competence

References

M. Schön (2007): GK1 Medizinische Psychologie und Soziologie. Springer Verlag.

K. Buser, T. Schneller, K. Wildgrube (2007): Kurzlehrbuch Medizinische Psychologie und Medizinische Soziologie. Elsevier Verlag.

S. Rothgangel (2010): Kurzlehrbuch Medizinische Psychologie und Soziologie. Thieme Verlag.

Beispielfragen HAWI via [teachSam](#)

Dunning-Kruger-Effekt via [Wikipedia](#)

Legal Note: Unless otherwise stated, all rights reserved by Lecturio GmbH. For further legal regulations see our [legal information page](#).

Notes