Project Module in Management and Applied Economics

Fall/Winter Term 2020

Thomas Dohmen, University of Bonn

Cognition
Concepts and Measurement

Cognitive Abilty/Intelligence

- Intelligence (or cognitive ability): “ability to understand complex ideas, to adapt effectively to the environment, to learn from experience, to engage in various forms of reasoning, to overcome obstacles by taking thought.“ (Neisser et al. 1996, p. 77)

- Term „IQ“ refers to scores on IQ test.

General Intelligence

- Most psychologists agree that cognitive abilities are organized hierarchically with “g” as the highest-order factor (Spearman, 1904).
- The order of a factor indicates its generality in explaining a variety of tests of cognitive ability with different emphases (for example, verbal ability, numeracy, coding speed, and other tasks).
- First-order factors are predictive in all tasks, j = 1, …, J.
- Lower order factors are predictive in only some tasks.

Crystallized vs. Fluid Intelligence

- Cattell (1971; 1987): two second-order factors:
  - **Fluid intelligence** (Gf): ability to solve novel problems
    - represents measurable aspects of the outcome of biological factors on intellectual development (i.e., heredity, injury to the central nervous system)
  - **Crystallized intelligence** (Gc): knowledge and developed skills
    - is considered the main manifestation of influence from education, experience and acculturation

What is Fluid Intelligence?

- Fluid cognitive functioning can be thought of as all-purpose cognitive processing not necessarily associated with any specific content domain

- Aspects of fluid cognition
  - Working memory
  - Executive function or cognitive control
  - Ability to abstract, to do hypothetical thinking

Interesting Evidence on Fluid and Crystallized IQ

- Crystallized IQ tends to increase monotonically for most of the life cycle
- Fluid IQ peaks in early adulthood and declines thereafter
  - Speed of decline?
  - Can biological process be affected?

- Flynn effect: Increase in performance on IQ tests over time

Life Cycle Pattern of Fluid and Crystallized Intelligence

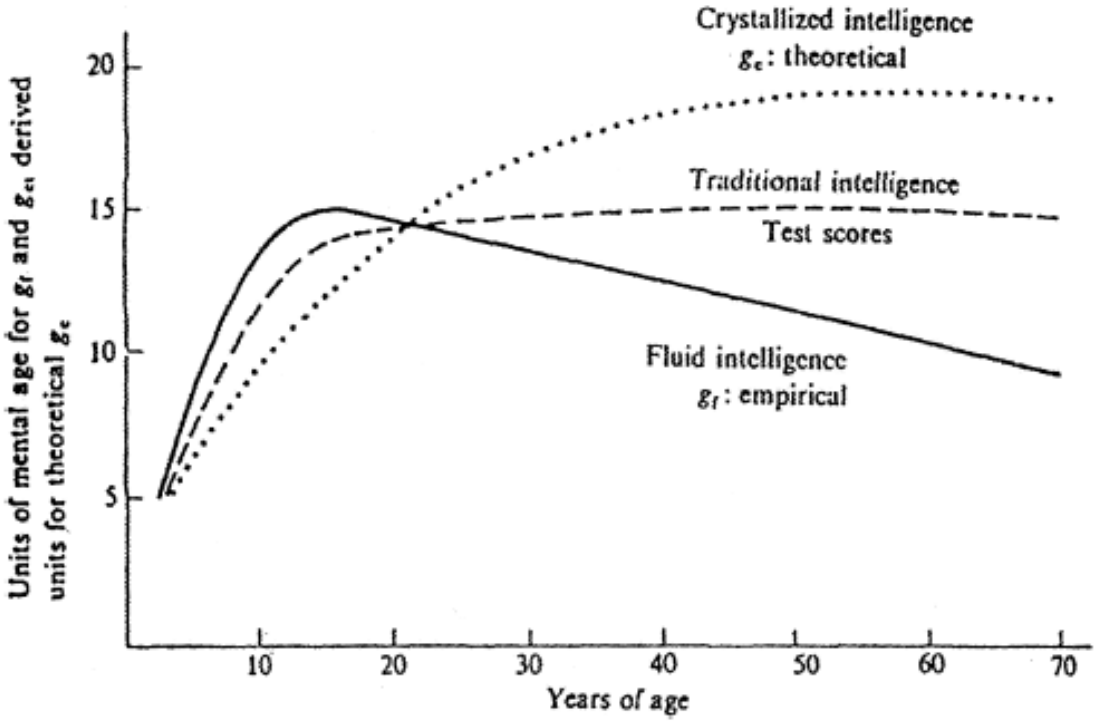


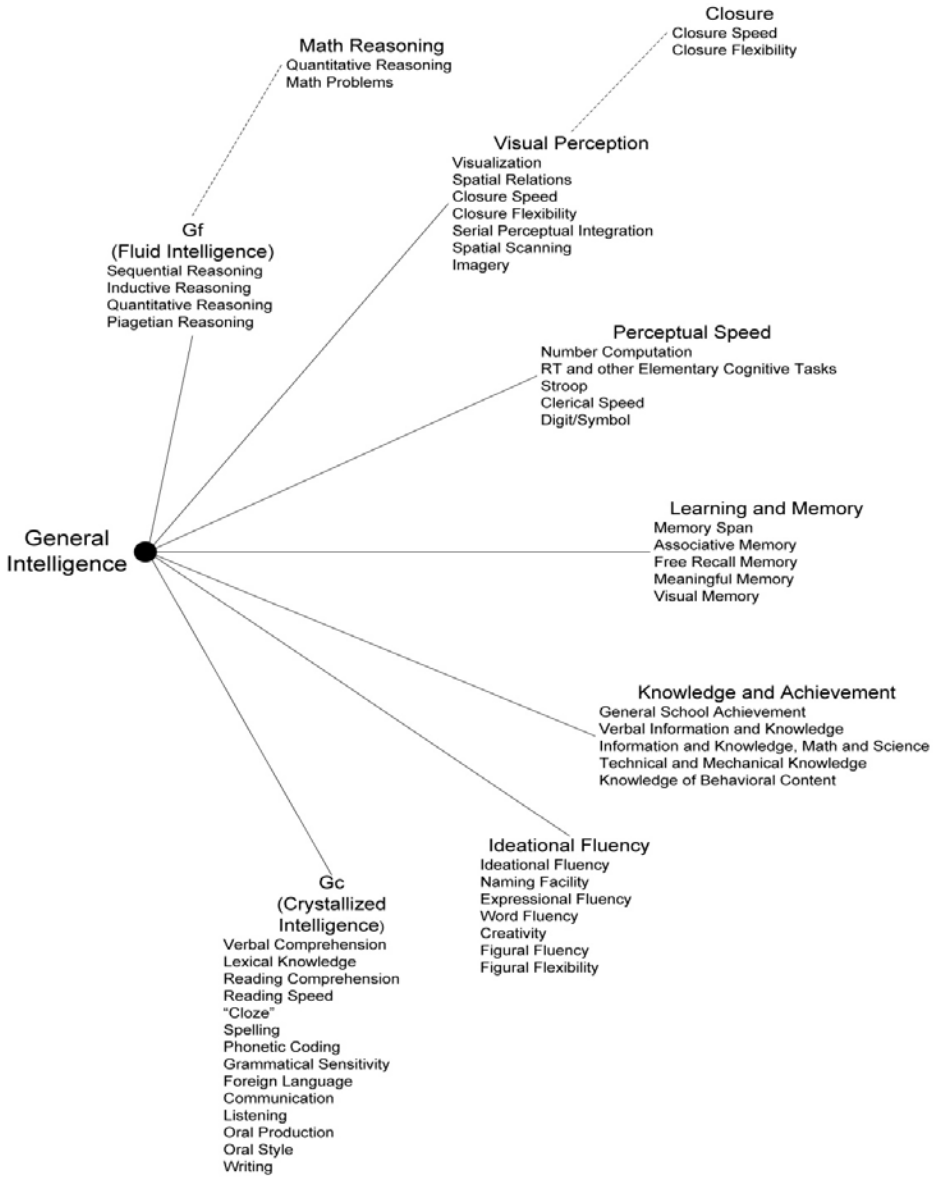
Figure 1. A theoretical description of life span curves of intellectual abilities. From *Intelligence: Its structure, growth and action* (p. 206) by R. B. Cattell, 1987, Amsterdam: North-Holland. Copyright 1987 by Elsevier Science Publishers. Reprinted with permission.

Alternative Organization of second-order Cognitive Factors

- Lubinski (2004):
  - Verbal, quantitative and spatial ability

- Carroll (1993):
  - Fluid-, crystallized intelligence, general memory and learning, visual perception, auditory perception, retrieval ability, cognitive speediness, and decision-making speed

Hierarchical Scheme of General Intelligence and its Components



Source: Recreated from Ackerman and Heggestad [1997].

IQ Testing

- History:
  - Binet
  - Cattell
  - Galton
  - Wechsler
    - Verbal subtests
    - Performance subtests
      - E.g. Raven Progressive Matrices

Other IQ Tests

- Wechsler developed a new version of the Stanford-Binet test
- Criticism on the Stanford-Binet test:
  1. Stanford-Binet tests depend too much on verbal skills and formal education
  2. The ratio of mental to chronological age was appropriate for adults

Wechsler Adult Intelligence Scale (WAIS)

- Wechsler´s score: $$IQ = 100 + \frac{15(x - \mu)}{\sigma}$$
- points achieved: x
- Average of the age group: μ
- Standard deviation: σ

Wechsler Adult Intelligence Tests

- Wechsler produced a new test divided into verbal and performance subtests (e.g., block design, matrix reasoning) – *WAIS and WISC*
- *WAIS: Wechsler Adult Intelligence Scale* Most widely used IQ test (for adults and adolescents ranging from 16 to 90 years of age).
  - *10 subtests and 5 supplemental tests*
- *WISC: Wechsler Intelligence Scale for Children*

Classification and Allocation of Intelligence

IQ	grade of intelligence	quotient (in %)
>127	extreme high	2,2
118-126	very high	6,7
110-117	high	16,1
91-109	Average	50
79-90	low	16,1
63-78	very low	6,7
<62	extreme low	2,2

Example WAIS: Verbal Subtests

- Information
  - Degree of general information acquired from culture (e.g. Who is the president of Russia?)
- Comprehension
  - Ability to deal with abstract social conventions, rules and expressions (e.g. What does "Kill 2 birds with 1 stone" metaphorically mean?)
- Arithmetic
  - Concentration while manipulating mathematical problems (e.g. How many 45c. stamps can you buy for a dollar?)
- Similarities
  - Abstract verbal reasoning (e.g. In what way are an apple and a pear alike?)
- Vocabulary
  - The degree to which one has learned, is able to comprehend and verbally express vocabulary (e.g. What is a guitar?)
- Digit span
  - Attention/concentration (e.g. Digits forward: 123, Digits backward 321.)
- Letter-Number Sequencing
  - attention and working memory (e.g. Given Q1B3J2, place the numbers in numerical order and then the letters in alphabetical order)

Performance Subtests

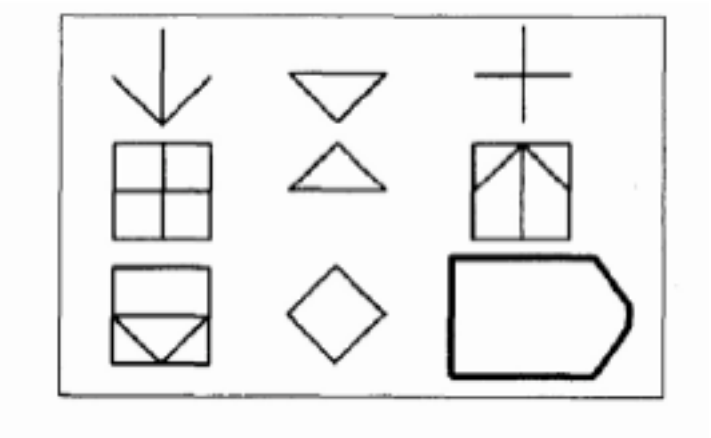
- Picture Completion
  - Ability to quickly perceive visual details
- Digit Symbol - Coding
  - Visual-motor coordination, motor and mental speed
- Block Design
  - Spatial perception, visual abstract processing & problem solving
- Matrix Reasoning
  - Nonverbal abstract problem solving, inductive reasoning, spatial reasoning
- Picture Arrangement
  - Logical/sequential reasoning, social insight
- Symbol Search
  - Visual perception, speed
- Object Assembly
  - Visual analysis, synthesis, and construction
- Optional post-tests include Digit Symbol, Incidental Learning, Digit Symbol, and Free Recall.

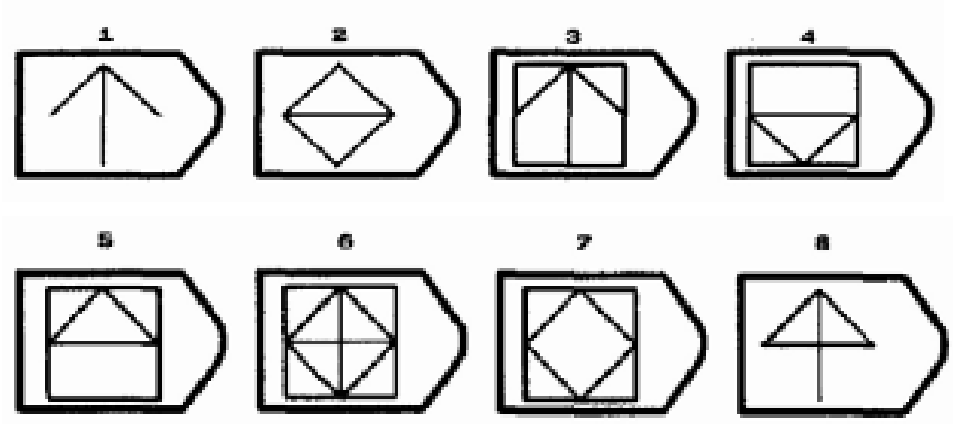
Raven‘s Progressive Matrices Test

- „culture free“ test:
  - Primarily independent from verbal skills or educational knowledge
- Designed to *predict* performance in school
- Almost an indicator for fluid intelligence

Example:

- Raven´s progressive matrices test items:

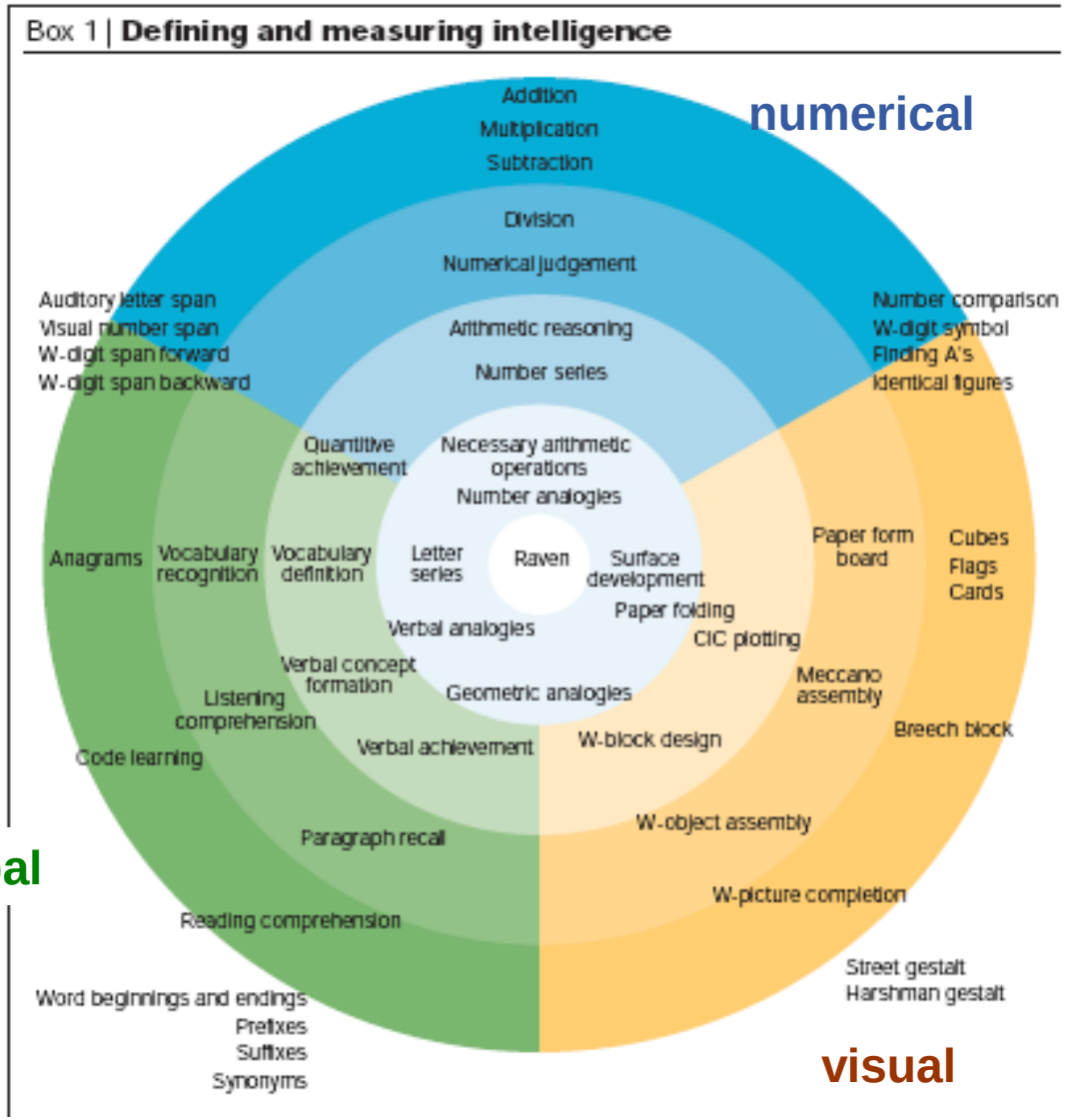




Some remarks on IQ tests

- IQ tests don’t reflect just intelligence:
  - IQ test scores are also determined by other factors such as motivation, curiosity, persistence and anxiety
- -> IQ tests reflect cognitive and non-cognitive traits

- More intelligent people are likely to perform strategically on the tests
- Test takers with low IQ scores increased their performance on IQ tests, when incentives were offered (see Table 3)
- Test takers high in emotional stability and conscientiousness are much less affected by incentives
- Low motivation and test anxiety can considerably impair the test performance
- IQ tests do not accurately reflect maximal intellectual performance
  - Important for interpretation of IQ on economic outcomes



How Fluid Intelligence is related to Psychometric g or IQ

Ravens matrix score is most loaded on g. Figure shows correlation of other tests with g.

Colors indicate nature of test

Distance from center indicates progressively weakening correlations

Source: J. R. Gray and P. M. Thomson (2004) *Nature, reproduced From Snow, et. al. (1984)*