Theories of Intelligence I: The Binet Scales

Psy 427
Cal State Northridge
Andrew Ainsworth PhD

Defining Intelligence
- Like any concept in psychology one of the principal challenges is defining intelligence
- In the face of this challenge there are many working definitions of intelligence proposed

Defining Intelligence
- Binet
  - “the tendency to take and maintain a definite direction; the capacity to make adaptations for the purpose of attaining a desired end, and the power of autocriticism”
- Spearman
  - The ability to educe either relations or correlates
- Gardner
  - The ability “to resolve genuine problems or difficulties as they are encountered”
Defining Intelligence

- There are many definitions and each tends to portray a general theory followed by the researcher
- Three independent research traditions in the study of intelligence
  - Psychometric – test structure (this and next chapter)
  - Information processing – learning and problem solving (Chapter 15)
  - Cognitive Approaches – adaptation to real-world demands (Chapter 15)

Instigating Intelligence Testing

- In France at the end of the 19th century
  - French minister made a controversial decision to try and identify intellectually limited children in order to remove them from regular classes
  - Supposedly, so they could receive specialized training to help bring them up to the intellect of their same-aged counterparts
  - 1904 the minister appoints a committee to recommend a procedure for identifying intellectually limited children

Two Early Principles

- Age differentiation
  - one can differentiate older children from younger children based upon their mental capacities
  - older children have greater skills than younger children
  - Mental age – knowledge and task ability of a specific age group
  - These abilities were assess and each respondent compared in the past
  - Today IRT is used to calculate the ability levels
Two Early Principles

• General Mental Ability
  • intelligence may be composed of several individual factors, but
  • Binet was interested in measuring the sum total of them all
  • Considered general intelligence

General Mental Ability

• First proposed by Galton (Hereditary Genius)
• Also independently proposed by Charles Spearman
  • Intelligence consists of one general factor (g) plus a large number of specific factors

Spearman’s g

• g acts like a single general factor
• The higher some scores on g the higher they are on the specific intelligences
• Approximately 50% of the variance in a set of diverse mental tests is represented by the g factor
  • Spearman developed factor analysis because he noticed that most, seemingly unrelated, abilities were positively correlated; this is known as positive manifold
Other Theories of Intelligence

- Howard Gardner – Multiple Intelligences
  - Eight different kinds of intelligence
    - Linguistic: the ability to use with clarity the core operations of language
      - politicians
    - Logical-Mathematical: logical, mathematical, and scientific ability
      - scientists
    - Intrapersonal: the ability to form an accurate model of oneself and to use that model to operate effectively in life
      - therapists, novelists
    - Interpersonal: the ability to notice and make distinctions among other individuals' moods, temperaments, motivations
      - politicians, religious leaders, therapists
    - Musical: the ability to use the core set of musical elements (pitch, rhythm, timbre)
      - musicians, singers, composers
    - Spatial: the capacity to perceive the world accurately and to recreate one's visual experience
      - sailors, engineers, sculptors, painters
Other Theories of Intelligence

- Howard Gardner – Multiple Intelligences
  - Eight different kinds of intelligence
  - Bodily-kinesthetic: control of one’s bodily motions and the ability to handle objects skillfully
  - Naturalistic: the ability to comprehend, classify and understand things encountered in the world of nature
  - farmers, ranchers, animal handlers, zoo keepers

- Horn & Noll (1977): gf-gc
  - gf: fluid intelligence
    - those abilities that allow us to reason, think, and acquire new knowledge
  - gc: crystallized intelligence
    - knowledge and understanding that we have acquired
    - “combined wisdom”

Binet Scales: History

History of the Stanford-Binet

- Binet & Simon (1905)
- Goddard (1913) & others
- Terman (1916)
- Terman & Merrill (1927)
- Merrill (1960, 1973)
- Thurstone, Hagen, & Sattler (1966)
- Roid (2003)
Binet’s Beginnings

• Binet begins with a unitary g model, one intelligence, in 1905.
  • 30 items, age scale
  • 3 levels of intellectual deficiency
  • Idiot – most severe impairment
  • Imbecile – moderate impairment
  • Moron – mild impairment
  • Problems
    • Question of unit
    • Small normative sample (50 children)
    • Limited Validity

Binet’s Beginnings

• 1908: age scale continues
  • Introduction of the term “mental age”
  • Described the level which an individual could reach on the 1908 scale
  • If you can perform tasks (e.g. answer questions) that can be performed by 2/3 to 3/4 of average 10 year olds, then you get a mental age of 10
  • Still, problems with single score & heavy verbal requirement

Binet’s Beginnings

• 1916: Binet’s test comes to the United States (via Louis Terman of Stanford)
  • Increased standardization sample (although all children in sample were white, native-californians)
  • Retained the notion of age differentiation (used an age scale)
  • Retained the notion of mental age
Binet’s Beginnings

• 1916: Binet’s test comes to the United States (via Louis Terman of Stanford)
  • combined mental age with chronological age to produce first intelligence quotient

\[ IQ = \frac{\text{Mental Age}}{\text{Chronological Age}} \times 100 \]

Binet’s Beginnings

• 1916: Binet’s test comes to the United States (via Louis Terman of Stanford)
  • Problems
    • Test topped out at a mental age of 19.5; everybody older than that would produce some kind of mental retardation (MA < CA)
    • So typically any mental age above 16 would be set at 16 (there was a belief at that time that Mental Age maxed at age 16)

Binet’s Beginnings

• 1937: Larger standardization sample
  • 11 states in standardization sample
  • More urban subjects than rural
  • Only whites included in standardization sample
  • Alternate forms constructed: L and M
  • Problems:
    • Different sd’s at each age for the standardization sample.
    • SD at age 6 = 12.5; SD at age 12 = 20.0
    • IQ’s at different ages were not comparable
Binet’s Beginnings

- 1960: Both forms of 1937 test combined to produce the Stanford Binet L-M
  - introduced the concept of a deviation IQ
  - mean 100; SD 16; deviation IQ determined by how far above/below the mean a person scored within a particular age band
  - 1960 norms better, still all white
  - 1972 - re-normed, included nonwhite standardization subjects for the first time

The Modern Binet Scales

- 1986/2003: Stanford Binet Intelligence Scale: Fourth and Fifth editions
  - Drastically revised items, and structure (hierarchical).
  - No longer dependent upon a unitary intelligence construct; theoretically-linked to the gf-gc and multiple intelligence model
  - Thurstone’s Multidimensional Model: intelligence is made up of primary mental abilities and these abilities in turn are driven by g.

Hierarchical Structure of SB4

- General Intelligence
  - Abstract/Visual Reasoning
  - Verbal Reasoning
  - Quantitative Reasoning
  - Working Memory
The SB4 Intelligence Model: The Subtests

- Routing Subtests used for “adaptive” testing
  - 1986
    - Used to test knowledge of words and their meaning
    - Highest level attained on vocabulary test indicates starting point for remainder of tests
    - This is used to gauge “age group” for test
      - “Vocabulary loads highly on g”
  - 2003
    - Added an additional non-verbal routing subtest

The SB4 Intelligence Model: The Subtests

- Routing Subtests used for “adaptive” testing
  - Once an age range is established using the routing subtest(s)
  - This helped to choose the level of the remaining items; start point
  - Basal – level at which a minimum number of correct responses is obtained
  - Ceiling – number of incorrect responses that indicate that the items are too difficult

The SB4: 15 Subtests

- Bead Memory
  - Two levels
    - Single & Double Bead displays for younger children
    - Sequential displays for older individuals
    - Used to test visual short-term memory
- Quantitative
  - Items presented visually, subject responds verbally
  - Scrap paper is permitted
  - Used to test quantitative skills (mathematics)
**The SB4: 15 Subtests**

- **Memory for Sentences**
  - Tests auditory short-term memory
  - Sentences are presented verbally, must be repeated verbally

- **Pattern Analysis**
  - Tests visual-spatial and motor skills
  - Arrays of blocks presented visually, blocks must be assembled by hand to match patterns

---

**The SB4: 15 Subtests**

- **Comprehension**
  - NOT a test of reading comprehension, but a test of social and moral reasoning
  - Items are presented verbally, must be answered verbally

- **Absurdities**
  - Another test of social, logical reasoning
  - Items are presented visually, must be answered verbally

---

**The SB4: 15 Subtests**

- **Memory for Digits**
  - Two subtests
    - digits forward
    - digits backward
  - BUT, both scores are combined for the subtest score
  - Taps short-term auditory memory and active working memory
The SB4: 15 Subtests

- Copying
  - Two levels
    - Copying blocks for younger children
    - Paper and pencil for older children
  - Tests visual-motor integration and visual spatial skills
- Memory for Objects
  - Tests sequential, visual, short-term memory
- Matrices
  - Tests non-verbal, logical-deductive reasoning

The SB4: 15 Subtests

- Number Series
  - Tests quantitative and logical-deductive reasoning
  - Scratch paper is allowed
- Paper Folding and cutting
  - Tests visual-spatial reasoning
  - No actual cutting occurs in actual test items, only for sample items
- Verbal Relations
  - Tests verbal, logical reasoning

The SB4: 15 Subtests

- Equation Building
  - Tests quantitative, logical, deductive reasoning skills and active working memory
SB4 Scoring Subtests

- Items in each subtest are administered to obtain basal and ceiling measures.
- Highest number item administered minus number of failed items = Raw Score
- Raw scores are converted into Standard Age Scores (Mean 50, SD of 8)
- Subtests are then combined to produce Area Scores

The Four SB4 Scales

- Verbal Reasoning Area
  - Vocabulary, Comprehension, Absurdities, Verbal relations
- Abstract/Visual Reasoning Area
  - Pattern Analysis, Copying, Matrices, Paper Folding & Cutting
- Quantitative Reasoning Area
  - Quantitative, Number Series, Equation Building
- Short-Term Memory Area
  - Bead Memory, Memory for Sentences, Memory for Digits, Memory for Objects

SB4 Scales and Scores

- Four Scales each produce their own Area Scores
- Four Area Scores are combined to produce a “Test Composite”
  - Mean 100, SD 16
Advantages of the SB4

- Based on modern theories of intelligence
  - gf-gc foundation
- Tests wide range of intelligences
- Tests wide range of ages with single instrument
  - Can test as young as 2 and as old as adulthood
- Strong reliability & validity
- More sensitive in higher end of abilities
  - Better to use for discrimination among gifted individuals
- Tests short-term memory explicitly

Disadvantages of the SB4

- Eliminated Age Scale for a point scale
- “Cumbersome” test
  - Taps many areas, requires tester to be facile with all 15 scales
  - DOES NOT require tester to obtain basal and ceiling measures on all 15 tests
- Possible ethnic/socio-economic biases
- Older norms than other child-based tests (at present)

Hierarchical Structure of SB5

<table>
<thead>
<tr>
<th>General Intelligence</th>
<th>Fluid Reasoning (FR)</th>
<th>Knowledge (KN)</th>
<th>Quantitative Reasoning (QR)</th>
<th>Visual/Spatial Reasoning (VS)</th>
<th>Working Memory (WM)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nonverbal</td>
<td>Nonverbal</td>
<td>Nonverbal</td>
<td>Nonverbal</td>
<td>Nonverbal</td>
</tr>
</tbody>
</table>
**Scoring of the SB5**

![Diagram](image)

**The SB5 Intelligence Model:**

**The Subtests**

- Routing Subtests used for “adaptive” testing
  - 2003
    - Added non-verbal routing subtest (i.e. Matrices) as an addition to the vocabulary test

**The SB5: 10 Subtests**

- Contains many of the subtests of SB4 but they have been altered/combined
- Represents abilities assessed by all former versions of the test
- The Fifth Edition reintroduces the age-scale format for the body of the test
  - Presenting a variety of items at each level of the test.
  - Intended to provide a variety of content to
  - Keep examinees involved in the testing experience
  - And to allow for the introduction of developmentally distinct items across levels
- The points system was also retained
The SB5: 10 Subtests

- The short-term memory was shifted over to a working memory model
- The other subscales remained essentially the same except
  - The addition of Visual/Spatial Reasoning
  - And a few changes to the names of the subscales

Changes from SB4 to SB5

Abstract/Visual Reasoning → Fluid Reasoning (FR)
Verbal Reasoning
Quantitative Reasoning (QR)
Short-Term Memory

Fluid Reasoning (FR)
Knowledge (KN)
Quantitative Reasoning (QR)
Visual/Spatial Reasoning (VS)
Working Memory (WM)

The SB5: 10 Subtests

<table>
<thead>
<tr>
<th>Fluid Reasoning (FR)</th>
<th>Numerical</th>
<th>Matrices</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge (KN)</td>
<td>Verbal</td>
<td>Analogies</td>
<td></td>
</tr>
<tr>
<td>Quantitative Reasoning (QR)</td>
<td>Numerical</td>
<td>Recognize Absurdities in Pictures</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Verbal</td>
<td>Vocabulary</td>
<td></td>
</tr>
<tr>
<td>Visual/Spatial Reasoning (VS)</td>
<td>Numerical</td>
<td>Quantitative Reasoning</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Verbal</td>
<td>Verbal Quantitative Reasoning</td>
<td></td>
</tr>
<tr>
<td>Working Memory (WM)</td>
<td>Numerical</td>
<td>Block Pattern Memory</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Verbal</td>
<td>Sentence Memory</td>
<td></td>
</tr>
</tbody>
</table>
Form Boards

SB5 Information

- Changed to using an SD of 15 instead of 16
- Much more game oriented (e.g. toys, brightly colored)
- Tapped into extremes in intelligence (2 – 85+ years)
- Standardized by stratified sample of 4800 respondents

SB5 Information

- Full-scale IQ reliability is .97 - .98 for each of age ranges
- Average reliabilities for the 3 IQs are .98 (full-scale), .95 (non-verbal), and .96 (verbal)
- Five factors range from .90 - .92
- Test-retest range from the .7s to the .9s
- Manual touts support for validity as well