**Intelligence**

What is it?
How can it be measured?
Where does it come from?

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**What is intelligence?**

- The ability to learn from experience, to apply knowledge to solve problems, to adapt & survive in different environments
- Several approaches
  - Psychometric (structural): specific abilities
  - Information processing: low-level processes
  - Neuropsychological: connections with brain functioning
  - Ecological: manifestations

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**Galton (1869)**

- Cousin of Darwin
- “Hereditary Genius”: genius seems to occur more often in certain family trees
- Suggested that children inherited a great ‘nervous system efficiency’ from their breeding
- Measurable with simple RT & perception tasks
- Not much luck with his studies but
- Invented a statistical procedure for assessing the relationship between different measures: correlation (YAY!)

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**Spearman’s theory of intelligence**

- Charles Spearman (1863-1945)
- Spearman’s theory of intelligence
  - developed to tease apart components of intelligence
  - are there clusters of correlations that suggest common underlying factors?

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**Cattell’s two-factor theory (1987)**

- Raymond Cattell (1905-1998)
- Cattell suggested two main factors in intelligence (g)
  - Fluid intelligence
  - Crystallized intelligence

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What might “g” be?
- mental speed and working memory?
- mental self-government?

Thurstone’s factor analyses showed 7 factors…
Cattell decided to reanalyse and got...
Cattell’s Two-factor theory

- Ability to perceive relationships independent of previous experience
- Examples: matrix reasoning, object assembly
- Ability peaks around age 20-25, then declines
- Mental ability derived directly from previous experience
- Examples: vocabulary, information
- Ability increases over the lifetime (esp. in an intellectually stimulating environment)
- Less influenced by alcohol consumption and brain damage

Correlation between Fl & Ci? r ~ .60

Gardner’s multiple intelligences

7 primary mental abilities:
- Linguistic
- Logical-mathematical
- Spatial
- Musical
- Bodily-kinesthetic
- Interpersonal
- Intrapersonal
- Non-hierarchic theory -- these have equal status
- Gardner’s evidence? idiot savants, localized brain damage
- Overcomes cultural bias, sort of…
- But is dance a mental ability…?

Criticism of structural theories

- Components are theoretical
  – Factor analysis is an art (number of factors and how they are interpreted is fairly arbitrary)
- Descriptive
- Static

Sternberg’s triarchic theory

Also multiple intelligences, but simpler:
- Componential intelligence
  – analytic
  – academic, problem-solving, resource allocation
- Experiential intelligence
  – creative
  – automated response to old problems, adaptive reactions to novel situations
- Contextual intelligence
  – practical
  – fitting in
  – ill-defined everyday problems

Emotional intelligence

- linked to social intelligence
- Comprehension of social situations, successful navigation of the social world
- Multifactor Emotional Intelligence Scale (Mayer, Salovey et al.) has 4 components
  – Perceive & identify emotions (E)
  – Use emotions to facilitate thought (E)
  – Understand emotions (S)
  – Regulate emotions (S)
- Does this stretch the definition too far?

Measurement

What for??? Does it matter?

World’s highest IQ
Marilyn Vos Savant
IQ: 228
Writes magazine advice column “Ask Marilyn”

Not world’s highest IQ
George W. Bush
IQ: estimated at 91
World’s most powerful job
Measurement

What for???

- Basic theory & research on individual differences
- Practical applications

We supposedly live in a meritocracy
- Who to train
- Who to hire

Sadly, IQ isn’t the best predictor of performance
- better IQ ≈ better performance (r ≈ 0.2-0.4)
- socioeconomic status of parents is a better predictor of achievement than by IQ (education, connections?)
- prediction is better for new than experienced employees

Stanford-Binet

- Binet’s scale adapted in the US by Terman at Stanford
- Extended upper end to adults
- IQ = MA x 100
  CA

- Recommended widespread use to identify “inequalities of children in original endowment”
  - repackaged as aptitude test (vs. achievement test)

Wechsler Adult Intelligence Scale

- Most widely used
- Lengthy individual testing
- 11 subscales
  - 6 verbal
  - 5 performance
- Mean = 100, stdev = 15

Binet

- France 1904
- Compulsory education for children introduced
- Binet asked to develop scale to assess current capability
- For the purpose of increasing attention of teachers on kids who need help to move along
- Assumed intelligence is a collection of abilities that grows as child grows
- Developed age norms ⇒ mental age
- Recommended „mental orthopedics“ for kids whose MA was lower than their CA

WW I

- WWI created a need for intelligence testing
- Stanford-Binet adapted by US govt for assessment of army recruits
- And later immigrants
- Huge differences between people of various backgrounds
- Led to 1924 immigration law reducing immigration quotas from Southern & Eastern Europe
- Cultural bias, perhaps?

WAIS-style Verbal Subtest Questions

- Vocabulary
  - What does emulate mean?
- Similarities
  - In what ways are airplanes and submarines alike?
- Information:
  - Who wrote The Great Gatsby?
- Comprehension
  - What does it mean when people say “Birds of a feather flock together”?
- Digit Span
  - Repeat the following numbers: 3 2 7 5 9
- Arithmetic
  - If you paid $8.50 for a movie ticket and $2.75 for a bucket of popcorn, how much change would you have left from a $20 bill?
WAIS-style Performance Subtest

- Block Design
- Picture Completion
- Picture Arrangement
- Object Assembly
- Digit Symbol

Look carefully at the key on the left. In the blanks on the right, write the correct numeral for the symbol below each symbol.

Assemble the blocks on the left to make the design on the right.

Arrange these pictures in an order that tells a story, and then tell what is happening in the story.

IQ scores follow a bell curve (normal) distribution

IQ scores can be used to classify intelligence

Raven’s matrices

IQ scores follow a bell curve (normal) distribution

IQ scores can be used to classify intelligence

Measurement controversies

- VALIDITY: What do intelligence tests measure?
  - Intelligence? Intelligence + other factors?
  - The effects of mental processes, not the mental processes themselves
  - Current skillset, not potential
  - Vernon’s “c” factor -- the kind of intelligence that is associated with intelligence tests

- SOCIAL CONSEQUENCES: Group differences?
  - Bias is possible if the test is used on a group for which no norms exist

Group differences

- Ethnic groups differ in average scores
- No overall gender differences
  - But estimations always favour men
  - Boys more variable
  - Boys better in spatial 3-D rotations (male hormones)
  - Girls better with memory
  - Girls better with emotion-detection
How to APPEAR smarter

• Be a man!
• Judging IQ from short videos
  Speak quickly, understandably, with lots of words
  → you seem bright, you are bright
  Usin’ slang, saying “um”, being overweight
  → you seem less bright, but not related

Talking loudly, using proper English,
→ you seem bright, but not related

(Judgments based on voice alone more accurate)

Nature vs Nurture

Nature
• Genetic factors/heritance
  • Stability
    – Individuals who are high or low in a characteristic
      will remain so at later ages

Nurture
• Environmental factors
  • Plasticity
    – Change is possible and likely if new experiences
      support it

Genetic influence

• Intelligence scores of identical twins
  – Reared together
  – Reared separately
  – Brain scans
• Adopted children
• Genetically modified mice
• With age, effect of genetics on intelligence
  scores GROWS

Environmental influence

• Greater among kids of less-educated
  parents (genes & environment correlate!)
• Early interventions
  – Malnutrition
  – Responsive caregiving
• Schooling

<table>
<thead>
<tr>
<th>Quality of environment (for realizing intellectual potential)</th>
<th>70</th>
<th>85</th>
<th>100</th>
<th>115</th>
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<td>Average</td>
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<td></td>
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<tr>
<td>Impoverished</td>
<td></td>
<td></td>
<td>75</td>
<td>65</td>
<td>55</td>
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</table>

Each person may have genes that set limits for intellectual potential.
Thinking

Private mental processes involving knowledge, usually toward some goal

Thinking changes your view of some aspect of the world

<table>
<thead>
<tr>
<th>Rational</th>
<th>Autistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adaptation to reality</td>
<td>Escape from reality</td>
</tr>
</tbody>
</table>

Problem Solving

Problems must have a goal
- daydreaming: not problem solving

PS involves getting from some initial state to some goal state.
- How do people find the intermediate steps?
  - Initial State - My car is low on gas
  - Goal State - A full tank of gas
  - Intermediate Steps - go to gas station and fill up tank

Problem Solving

- Well-defined
  - I need to get to CinemaCity by 15:15
  - Explicit, single solution
  - All information necessary to solve is available
  - Steps to solution are known
- Ill-defined
  - I need to buy my boss an impressive gift
  - Some aspect underdefined
    - Goal is unclear: several different results could satisfy the goal
    - Not enough information (what is the address of the party?)
    - Best strategy unclear (how can I get there?)

Problem Solving: Logical strategies

- reproductive strategy: recall
- trial and error
  - random, blind attempts of series of solutions until one works
  - for tasks where there is little precedent – plain jigsaw
- means-end analysis
  - repeatedly check current situation against the goal state, look at how to reduce difference (directional)
  - allows us to break the problem solving into subgoals and partial solutions
  - this in turn leads to greater efficiency (automatization)
- algorithms
  - procedure that is guaranteed to produce a solution if followed correctly
  - sometimes slow & effortful

Trade-off

Judgment: drawing conclusions from a combination of knowledge and observation

Algorithms: step by step operations which guarantee solution, sometimes too slow and effort consuming

Heuristics: shortcuts, rules of thumb that usually work, but not always—efficient but risky

The Gestalt of problem solving

- Gestalt and Perception
  - People (and other animals) generally do not perceive the individual pieces or features in a scene, but extract their relationship
  - the key to problem solving is to extract the relationship
    - understanding the relationship between items, especially non-obvious relationships, is what allows us to solve problems
Difficulties in Problem Solving

One of the keys to problem solving is to be able to see all the possible relationships between objects and concepts.

- **Functional fixedness**
- More broadly, **negative set (Einstellung)**
  - A bias to solve problems in only one way: *If you have a hammer, everything looks like a nail*
  - can occur when people are stuck using a single problem-solving technique even when others might be more efficient
- **Confirmation bias**

Difficulties in Problem Solving

- **Functional Fixedness**
  - The tendency to use objects and concepts in only their usual way.
  - Ex: Two strings are suspended from the ceiling, and the goal is to tie them together. The strings are too far apart for a person to hold one, reach the other, and tie them together. Available are: a chair, some paper, and a pair of pliers. Standing on the chair does not bring the strings close enough. How can you tie the strings together?
  - Why do we have problems with **functional fixedness**?
  - When we access or semantic knowledge about something (e.g., pliers), we recall the normal properties and uses of an object (e.g., turning bolts).
  - We recall how it has been used, not how it could be used

Jugs Experiment

<table>
<thead>
<tr>
<th>Problem</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>Goal</th>
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<tr>
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<tr>
<td>...</td>
<td>28</td>
<td>59</td>
<td>3</td>
<td>25</td>
</tr>
</tbody>
</table>

- All of these examples can be solved by using: \( B - 2C - A \)
- 1 group of subjects were given the set of problems preceding problem #8 (experimental group)
- Another were just given #8 (control)
- Experimental gp’s solution less efficient than control’s

Confirmation Bias

The tendency to look for evidence that confirms a hypothesis, but not for evidence that would falsify it.

**THE STROOP EFFECT**

When automaticity gets in the way
Primacy effects

Because you never get a second chance to make a first impression . . .

Asch (1946)
Steve is intelligent, industrious, impulsive, stubborn, critical, and envious.
Steve is envious, critical, stubborn, impulsive, industrious, and intelligent.

Automaticity gone wild

Framing

Kahneman & Tversky (1984)

What affects our choices?
1. value of alternative (more is better)
2. probability of alternative (higher better)

Classic decision making theory is based on these 2 points… but…

Imagine that your country is preparing for the outbreak of an unusual disease, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimate of the consequences of the two programs is as follows:

If Program A is adopted, 200 people will be saved.
If Program B is adopted, there is a 1/3 probability that 600 people will be saved and a 2/3 probability that no people will be saved.

What affects our choices?
1. value of alternative (more is better)
2. probability of alternative (higher better)
3. framing -- phrasing of alternatives

Automaticity gone wild

Availability heuristic

Schwarz et al (1991)

Group 1: Think of six times you have acted assertively
Group 2: Think of twelve times you have acted assertively

Which group rated themselves as more assertive?
Automaticity gone wild
Representativeness heuristic

Which is more likely: THTHTHTH or TTTTTTTTTT?

“Steve is very shy and withdrawn, invariably helpful, with little interest in people, or the world of reality. A meek and tidy soul, he has a need for order and structure and a passion for detail.” Is Steve a farmer or a librarian?

When we try to categorize something, we often ignore base rates and instead judge how similar something is to our idea of the typical case.

Studying Problem Solving

• Studying problem solving is particularly difficult because solving problems is a lengthy task that involves many mental calculations.
  – Therefore, the usual measures of RT and accuracy aren’t always useful.
  – Instead, verbal protocol, is often used.
    • verbal protocol has its problems:
      – The act of verbalizing the steps might change how the person solves the problem.
      – Is introspection really that accurate?