Intelligence

Everyone is a genius. But if you judge a fish on its ability to climb a tree, it will live its whole life believing that it is stupid.

-A Einstein

PSY 101:002 Chapter 10
What is Intelligence?

- Intelligence is a mental quality consisting of the ability to learn from experience, solving problems, and use knowledge to adapt to new situations.
What is Intelligence?

• This definition isn’t tied to any particular context. For example, adapting to new situations could refer to the transition from living at home to living on your own, or to the transition that Brazilian tribespeople must make as a result of destruction of the rain forest.
What is Intelligence?

- Is intelligence one general ability or several specific abilities?

- **Charles Spearman** believed we have one general intelligence—and he had a good reason for believing this.
What is Intelligence?

• Is intelligence one general ability or several specific abilities?

• Spearman found that people who do well on one test of mental ability tend to do well on all others, implying that there is a “key ingredient” for success across tests, which he identified using a statistical tool called factor analysis, and which he called the general factor (shortened to g).
Theories of Multiple Intelligences

• **Gardner’s theory** – intelligence is best thought of as multiple abilities that come in packages.

**TABLE 10.1**

<table>
<thead>
<tr>
<th>Gardner’s Eight Intelligences</th>
<th>Aptitude</th>
<th>Exemplar</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Linguistic</td>
<td></td>
<td>T. S. Eliot, poet</td>
</tr>
<tr>
<td>2. Logical-mathematical</td>
<td></td>
<td>Albert Einstein, scientist</td>
</tr>
<tr>
<td>3. Musical</td>
<td></td>
<td>Igor Stravinsky, composer</td>
</tr>
<tr>
<td>4. Spatial</td>
<td></td>
<td>Pablo Picasso, artist</td>
</tr>
<tr>
<td>5. Bodily-kinesthetic</td>
<td></td>
<td>Martha Graham, dancer</td>
</tr>
<tr>
<td>6. Intrapersonal (self)</td>
<td></td>
<td>Sigmund Freud, psychiatrist</td>
</tr>
<tr>
<td>7. Interpersonal (other people)</td>
<td></td>
<td>Mahatma Gandhi, leader</td>
</tr>
<tr>
<td>8. Naturalist</td>
<td></td>
<td>Charles Darwin, naturalist</td>
</tr>
</tbody>
</table>

Most g-loaded abilities

May learn best via lecture

Navigation, face recognition

May learn best by moving

What are your weaknesses?

Communicators/empathizers

Sensitive, ethical, and holistic understanding
Theories of Multiple Intelligences

After a 30-minute helicopter ride to the top of a skyscraper, British savant artist Stephen Wiltshire began seven days of drawing that reproduced the Tokoyo skyline.

- **Savant syndrome** – a condition in which a person otherwise limited in mental ability has an exceptional specific skill, such as in computation or drawing.
Theories of Multiple Intelligences

Kim Peek was able to read and remember a page in 8 to 10 seconds, and had memorized verbatim 9,000 books, including the complete works of Shakespeare. Yet he could not remember to button his clothes.

https://www.youtube.com/embed/AfDEAlszuQI#t=11
https://www.youtube.com/watch?v=4wjqMtNF3Ms

- Savant syndrome – a condition in which a person otherwise limited in mental ability has an exceptional specific skill, such as in computation or drawing.
Theories of Multiple Intelligences

Daniel Tammet recited the first 22,514 digits of pi from memory in 5 hours and 9 minutes. Has learned 10 languages, including Icelandic in one week. [http://www.youtube.com/watch?v=z22H89rIMHk](http://www.youtube.com/watch?v=z22H89rIMHk)

- **Savant syndrome** – a condition in which a person otherwise limited in mental ability has an exceptional specific skill, such as in computation or drawing.
Theories of Multiple Intelligences

• For Gardner, a test score reflecting “general intelligence” is **essentially meaningless**, because a person can have weaknesses in some areas, but strengths in others. However, see below.
Theories of Multiple Intelligences

• **Sternberg’s theory** – distinguishes among three intelligences

  1. **Analytical Intelligence** – intelligence tests
  2. **Creative Intelligence** – adapting and generating novel ideas
  3. **Practical Intelligence** – attaining a fit between oneself and their environment, or “street smarts”

• [https://www.youtube.com/embed/L7C7qIRYiv0](https://www.youtube.com/embed/L7C7qIRYiv0)
# Theories of Multiple Intelligences

## Table 10.2: Comparing Theories of Intelligence

<table>
<thead>
<tr>
<th>Theory</th>
<th>Summary</th>
<th>Strengths</th>
<th>Other Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spearman’s general intelligence (g)</td>
<td>A basic intelligence predicts our abilities in varied academic areas.</td>
<td>Different abilities, such as verbal and spatial, do have some tendency to correlate.</td>
<td>Human abilities are too diverse to be encapsulated by a single general intelligence factor.</td>
</tr>
<tr>
<td>Thurstone’s primary mental abilities</td>
<td>Our intelligence may be broken down into seven factors: word fluency, verbal comprehension, spatial ability, perceptual speed, numerical ability, inductive reasoning, and memory.</td>
<td>A single (g) score is not as informative as scores for seven primary mental abilities.</td>
<td>Even Thurstone’s seven mental abilities show a tendency to cluster, suggesting an underlying (g) factor.</td>
</tr>
<tr>
<td>Gardner’s multiple intelligences</td>
<td>Our abilities are best classified into eight independent intelligences, which include a broad range of skills beyond traditional school smarts.</td>
<td>Intelligence is more than just verbal and mathematical skills. Other abilities are equally important to our human adaptability.</td>
<td>Should all of our abilities be considered intelligences? Shouldn’t some be called less vital talents?</td>
</tr>
<tr>
<td>Sternberg’s triarchic</td>
<td>Our intelligence is best classified into three areas that predict real-world success: analytical, creative, and practical.</td>
<td>These three facets can be reliably measured.</td>
<td>1. These three facets may be less independent than Sternberg thought and may actually share an underlying (g) factor.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2. Additional testing is needed to determine whether these facets can reliably predict success.</td>
</tr>
</tbody>
</table>
PSY 101: Mini-quiz Question

Intelligence can be defined as a mental quality that consists of

A. the ability to learn from experience.
B. the ability to solve problems.
C. the ability to use knowledge to adapt to new situations.
D. All of these mental qualities define intelligence.
PSY 101: Mini-quiz Question

Adam is a bright young man, who scored very high on both the Critical Reading and Mathematics sections of the SAT. He is an excellent map-reader and his reasoning abilities are fantastic. According to Spearman, what is likely underlying these abilities?

A. practical intelligence
B. enriched school environment
C. general intelligence (g) factor
D. logical and mathematical intelligence
PSY 101: Mini-quiz Question

_______________ is often required for everyday tasks, which are frequently ill-defined, with multiple solutions.

A. Creative intelligence
B. Analytical intelligence
C. Fluid intelligence
D. Practical intelligence
PSY 101: Mini-quiz Question

_________________________ is assessed by intelligence tests, which present well-defined problems having a single right answer.

A. Emotional intelligence
B. Analytical intelligence
C. Fluid intelligence
D. Practical intelligence
PSY 101: Mini-quiz Question
Sometimes intelligence is determined by

A. pressing “A” for a free point.
Intelligence and Creativity

- **Creativity** – the ability to produce ideas that are both novel and valuable, such as works of art.
Intelligence and Creativity

• Creativity – the ability to produce ideas that are both novel and valuable, such as the “Turing machine,” which can simulate the logic of any computer algorithm.

• [http://www.youtube.com/watch_popup?v=3BEAxoknHgo&vq=medium](http://www.youtube.com/watch_popup?v=3BEAxoknHgo&vq=medium)

• [http://www.youtube.com/watch_popup?v=AgW6HplOZV0&vq=medium&t=29](http://www.youtube.com/watch_popup?v=AgW6HplOZV0&vq=medium&t=29)
Intelligence and Creativity

- **Creativity** – the ability to produce ideas that are both novel and valuable, such as the paperclip. Requires divergent thinking.

Johan Vaaler’s first American patent, dated June 4, 1901, showed several embodiments of a “paper clip or holder.” The version labeled “Fig. 12” suggests the beginnings of what has come to be known as the Gem paper clip, but is clearly not a fully formed Gem.
Components of Creativity?

• Research suggests that people who are highly creative know a lot about their domain (expertise), think about things in novel ways (imagination), are willing to go against trends (personality), and are driven by interest, satisfaction, and challenge rather than external pressure (intrinsic motivation).
Components of Creativity?

• But the **environment** is also important.
  – Poem study example
Components of Creativity?

- But the **environment** is also important.
  - Brainstorming as a group and creative ideas – does it work?
  - 4 person groups = Average of 28 ideas
  - Four individuals working along = Average of 75 ideas
  - Independent raters: 80% of the good ideas came from individuals
Components of Creativity?

- But the **environment** is also important.
  - Mating and creativity?
Is Intelligence Neurologically Measureable?

Brain Size and Complexity

English poet **Lord Byron** had a very large head, and a very large brain—5 pounds compared to an average of 3 pounds.
Is Intelligence Neurologically Measureable?

Brain Size and Complexity

- Chris Langan’s IQ of 190 is about 6 standard deviations above the mean—as is his head size.
Is Intelligence Neurologically Measureable?

Brain Size and Complexity

- One review of 37 brain-imaging studies revealed associations between intelligence and brain size in specific areas, especially **frontal lobes**, and the correlation between overall brain size and intelligence is around .30.
Is Intelligence Neurologically Measureable?

**Brain Function**

• How does the “mental machinery” of someone who scores well on intelligence tests differ from that of someone who does not? In the test of **perceptual speed** below, a stimulus is flashed and is then replaced by a **masking** image. The critical question is: How long does a person need to glimpse the stimulus to answer the question correctly?

**Question:** Long side on left or right?
PSY 101: Mini-quiz Question

University students who focus on the interest and challenge of their schoolwork, rather than on simply meeting deadlines and securing good grades, are especially likely to demonstrate

A. emotional intelligence.
B. creativity.
C. factor analysis.
D. convergent thinking.
PSY 101: Mini-quiz Question
Convergent thinking is to ________________ as divergent thinking is to ________________.

A. a single correct answer; multiple answers
B. multiple answers; a single correct answer
C. Both demand a single correct answer.
D. Both produce multiple answers.
PSY 101: Mini-quiz Question

Bruce wants to foster creativity in his daughter, therefore he

A. provides lots of rewards for creative ideas and punishments for uncreative ideas.
B. takes her on long trips to other countries.
C. makes her watch at least 3 hours of TV a day.
D. A and B are both correct answers.
PSY 101: Mini-quiz Question
There is _____ correlation between intelligence scores and the speed of taking in perceptual information.

A. a negative
B. a positive
C. no
D. a +1.2
There is _____ correlation between intelligence scores and brain size (especially the frontal and parietal lobes).

A. a negative
B. a positive
C. no
D. a +1.2
Assessing Intelligence

Origins of Intelligence Testing

• Francis Galton had a fascination with measuring human traits, and devised the first tests of mental ability, which he administered to people in his laboratory at the 1884 London Exposition.
Assessing Intelligence

Origins of Intelligence Testing

- Alfred Binet (Predicting School Achievement) with the help of his assistant Théodore Simon, developed the first standardized test of intelligence for the purpose of identifying French schoolchildren who were in need of special help in school.

- Binet also introduced the concept of mental age – the chronological age that most typically corresponds to a given level of performance.
Assessing Intelligence
Origins of Intelligence Testing

- The Innate IQ
- Subsequently, Stanford University psychologist Lewis Terman translated the Binet-Simon into English. The Stanford-Binet is now one of the most widely administered tests of intelligence in the world.
Assessing Intelligence

Origins of Intelligence Testing

• The Innate IQ

• Terman also used the intelligence quotient as a way of expressing a person’s score (note: no longer computed this way)

\[
IQ = \frac{\text{Mental Age}}{\text{Chronological Age}} \times 100
\]
Over the course of your career as a student, you have taken many tests of mental abilities, including **aptitude tests**—tests, like the ACT, that are designed to predict your future performance—and **achievement tests**—tests designed to assess what you have learned. You may have also taken “intelligence tests.”

![IQ vs. SAT scores graph](image-url)
There are two major steps in **standardizing** a test. The first is to establish a procedure for administering the test, and the second is to administer the test to a standardization sample to establish norms for the test, and to determine whether the test has acceptable **measurement properties**.
Assessing Intelligence

Principles of Test Construction

- **Reliability** refers to the extent to which a test yields consistent results (scores), as assessed by the consistency of the scores on two halves of the test, or on retesting.

<table>
<thead>
<tr>
<th></th>
<th>Measurement 1</th>
<th>Measurement 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taylor</td>
<td>50</td>
<td>52</td>
</tr>
<tr>
<td>Kendra</td>
<td>61</td>
<td>59</td>
</tr>
<tr>
<td>Mateo</td>
<td>65</td>
<td>64</td>
</tr>
<tr>
<td>Kurt</td>
<td>75</td>
<td>80</td>
</tr>
</tbody>
</table>
Assessing Intelligence

Principles of Test Construction

- **Validity** refers to the extent to which a test measures what it is supposed to measure.

- The SAT and ACT are **highly reliable**, and they do an okay job of predicting the behaviors they are supposed to predict (**validity**). In other words, they correlate with college GPA.
The Dynamics of Intelligence

Stability or Change?

• Ian Deary and colleagues at the University of Edinburgh (Scotland) retested 80-year-old Scots, using an intelligence test they had taken as 11-year-olds. Across seven decades, scores correlated .66.
The Dynamics of Intelligence
Stability or Change?

Using the same sample, these researchers also found that IQ correlates with **longevity**: Among girls scoring in the highest 25%, 70 percent were alive at age 76, compared to only 45 percent of the girls who scored in the bottom 25%.

But, why?
PSY 101: Mini-quiz Question
If 10-year-old Monica had responded to the original Stanford-Binet with the proficiency of an average 20-year-old adult, she would be said to have an IQ of

A. 50
B. 100
C. 200
D. You need more information.
PSY 101: Mini-quiz Question

Your 75-year-old aunt has been a nun all her life. In her teens, she wrote essays that indicated she had HIGH verbal abilities. What can you predict about your aunt's cognitive function as she ages?

A. She is LESS at risk for Alzheimer's disease than same-aged women who showed LESS verbal ability.

B. She is MORE at risk for Alzheimer's disease than same-aged women who showed LESS verbal ability.

C. She is MORE at risk for Alzheimer's disease than same-aged men who showed LESS verbal ability.

D. You cannot predict how your aunt's cognitive function will change.
PSY 101: Mini-quiz Question
At age 16, Angel's intelligence score was 110. What will her score probably be at age 32?

A. 105
B. 110
C. 115
D. There is no way to predict an individual's future intelligence scores.
Comparing the academic accomplishments of those who score extremely low with those who score extremely high on intelligence tests is an effective way to highlight the _____________ of the tests.

A. standardization
B. heritability
C. reliability
D. validity
An _______________ measures a person's capacity to learn, whereas an _______________ measures what a person has already learned.

A. achievement test; aptitude test
B. aptitude test; achievement test
C. IQ test; aptitude test
D. achievement test; IQ test
The Dynamics of Intelligence

Extremes of Intelligence

About 95 percent of all people fall within 30 points of 100.

About 68 percent of people score within 15 points above or below 100.

Wechsler intelligence score
The Dynamics of Intelligence

Extremes of Intelligence

• **Low Extreme**

• **Intellectual disability** is a condition of limited mental ability, indicated by an intelligence test score of 70 or below and difficulty in adapting to normal demands of independent living.

<table>
<thead>
<tr>
<th>Level</th>
<th>Approximate Intelligence Scores</th>
<th>Adaptation to Demands of Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild</td>
<td>50–70</td>
<td>May learn academic skills up to sixth-grade level. Adults may, with assistance, achieve self-supporting social and vocational skills.</td>
</tr>
<tr>
<td>Moderate</td>
<td>35–50</td>
<td>May progress to second-grade level academically. Adults may contribute to their own support by laboring in sheltered workshops.</td>
</tr>
<tr>
<td>Severe</td>
<td>20–35</td>
<td>May learn to talk and to perform simple work tasks under close supervision but are generally unable to profit from vocational training.</td>
</tr>
<tr>
<td>Profound</td>
<td>Below 20</td>
<td>Require constant aid and supervision.</td>
</tr>
</tbody>
</table>

*Source: Reprinted with permission from the *Diagnostic and Statistical Manual of Mental Disorders*, Fourth Edition, text revision. Copyright 2000 American Psychiatric Association.*
The Dynamics of Intelligence

Extremes of Intelligence

• High Extreme

• Lewis Terman identified youth with an IQ over 135, and found that many, though not all, went on to attain high levels of education, and to become professionals—doctors, lawyers, professors, scientists and writers.
The Dynamics of Intelligence

Extremes of Intelligence

• High Extreme

• Lubinski and colleagues found that individual differences in IQ matter even at the high end of the scale. For example, people who had scored in the 99.9th percentile on the SAT as children were five times more likely to have a scientific patent than those who had “only” scored in the 99.1th percentile.
Genetic and Environmental Factors
Twin and Adoption Studies

- The logic of twin studies: If intelligence (or any other trait) is influenced by genetic factors, then the most genetically similar people should have the most similar intelligence test scores.

![Graph showing similarity of intelligence scores for different types of twins and unrelated individuals.](image)
Genetic and Environmental Factors

Twin and Adoption Studies

- **Heritability**: an estimate of the proportion of the variability in a trait that is attributable to genetic factors (heritability estimates for intelligence range from 50% to 75%).
Genetic and Environmental Factors
Twin and Adoption Studies

• But the graph also shows evidence for a contribution of environmental influences. For example, identical twins separated at birth and reared apart are less similar than identical twins reared together.
Genetic and Environmental Factors
Twin and Adoption Studies

Child-parent correlation in verbal ability scores

- Children and their birth parents
- Adopted children and their birth parents
- Adopted children and their adoptive parents

3 years vs. 16 years
Genetic and Environmental Factors

• In every country that has been studied, intelligence test scores rose during the 20th century. As a case in point, in Britain, test scores have risen 27 points since 1942. (This effect is called the **Flynn effect**, in honor of researcher James Flynn, who first documented its magnitude.)

https://www.youtube.com/watch?v=45ZmKfND-IM
Genetic and Environmental Factors

Early Environmental Influences

• In one study, Romanian orphans who had minimal interaction with caregivers were observed to suffer delayed development.
Genetic and Environmental Factors

Early Environmental Influences

• On the bright side, “enrichment” experiences such as Head Start and musical training can enhance intelligence—although the benefits are modest.
PSY 101: Mini-quiz Question

_______________ refers to the extent to which differences among people are attributed to genes.

A. Behavior genetics
B. The human genome
C. Heritability
D. Molecular genetics
PSY 101: Mini-quiz Question
As adopted children get older, their intelligence scores

A. become MORE like their adoptive parents.
B. become MORE like their adoptive siblings.
C. become MORE like their biological parents.
D. become LESS like their biological parents.
PSY 101: Mini-quiz Question

Your sister's identical twin sons are participating in a research study that includes MRI scans. The MRI findings will most likely indicate that

A. the areas in their brains associated with verbal intelligence are very different.
B. the areas in their brains associated with spatial intelligence are very different.
C. they have very similar gray matter volume.
D. they have very different gray matter volume.
Genetic and Environmental Factors

Gender Similarities and Differences

- **Greater male variability**: Boys are overrepresented in the low extreme and the high extreme of the distribution.
There are also **gender differences** in mean levels of mental abilities. Females are better spellers than males, and are better in remembering locations of objects.
Genetic and Environmental Factors
Gender Similarities and Differences

• Males tend to be better in spatial visualization.

Which two circles contain a configuration of blocks identical to the one in the circle at the left?

Standard

Responses
Genetic and Environmental Factors
Gender Similarities and Differences

• Even when gender differences are found, there is always substantial overlap (like the figure on the right) between the score distributions for males and females.
Genetic and Environmental Factors

Ethnic Similarities and Differences

• Differences in intelligence test scores are also found between **ethnic groups**. However, it is important to keep in mind that nature draws no sharp boundaries between races.

• Even if the variation between members within a group reflect genetic differences, the average difference between the group may be wholly due to the environment. Imagine that seeds from the same mixture are sewn in different soils. Height differences within each window box will be genetic, but the height difference between the boxes will be environmental.
The Question of Bias

• **Stereotype threat**: Apprehension felt by members of negatively stereotyped groups when their behavior might confirm the stereotype

• Claude Steele: members of stigmatized groups can fear being seen “through the lens of diminishing stereotypes and low expectations.”

• Stereotype threat can create an apprehension leading to decreased performance on academic tasks

• When reminded of negative stereotypes about their group, targets of those stereotypes (Steele & Aronson, 1995):
  → feel anxiety and self-doubt
  → show reductions in working memory capacity
  → underperform, relative to non-stereotyped others
The Question of Bias

- **Stereotype threat** (Steele & Aronson, 1995)
The Question of Bias

- **Stereotype threat** (Steele & Aronson, 1995)

Black students either filled out their race before the test (reminded of negative stereotypes about their intelligence) or not.
The Question of Bias

- **Stereotype threat** (Spencer, Steele, & Quinn, 1999)

Women either filled out their gender before the test (reminded of negative stereotypes about their math abilities) or not.
The Question of Bias

• **Stereotype threat** (Shih et al.)

Asian-American women take a quantitative test
Randomly assigned to:
  a) Female-identity salient condition
(had to indicate sex and answer questions related to gender identity)
b) Asian-identity salient condition
(had to indicate ethnicity and answer question relation to ethnic identity)

Mean accuracy (come to lecture for results)

  Asian Identity Salient: 
  No Identity Salient: 
  Female Identity Salient: 

PSY 101: Mini-quiz Question

In terms of gender differences in intellectual abilities, boys

A. outnumber girls in special education classes.
B. are better spellers.
C. scored lower in spatial visualization in 20 of 21 countries.
D. All of these intellectual abilities can be attributed to males.
PSY 101: Mini-quiz Question

Stereotype threat is most likely to depress female students' performance on a difficult ______________ test and to depress male students' performance on a difficult ______________ test.

A. math problem solving; verbal fluency
B. verbal fluency; math problem solving
C. spelling; athletic
D. spelling; spatial reasoning
PSY 101: Mini-quiz Question

In a study not discussed in lecture, when White and Black participants played a game of miniature golf, the White participants outperformed Black participants when the game was framed as __________, but Black participants outperformed White participants when the game was framed as ___________.

A. Black participants did better no matter the condition.
B. a measure of natural athleticism; a measure of sports intelligence.
C. a measure of sports intelligence; a measure of natural athleticism.
D. Both groups performed the same regardless of condition.
Chapter Review

• What is intelligence? What are key questions about intelligence?
• What is known about the relationship between intelligence and creativity?
• What are key components of creativity?
• Is intelligence neurologically measurable?
• What are the origins of intelligence testing?
• How is intelligence assessed today? What is reliability and validity?
• How does intelligence change over time?
• What is known about genetic vs. environmental influences on intelligence? And group differences?
• What is stereotype threat?