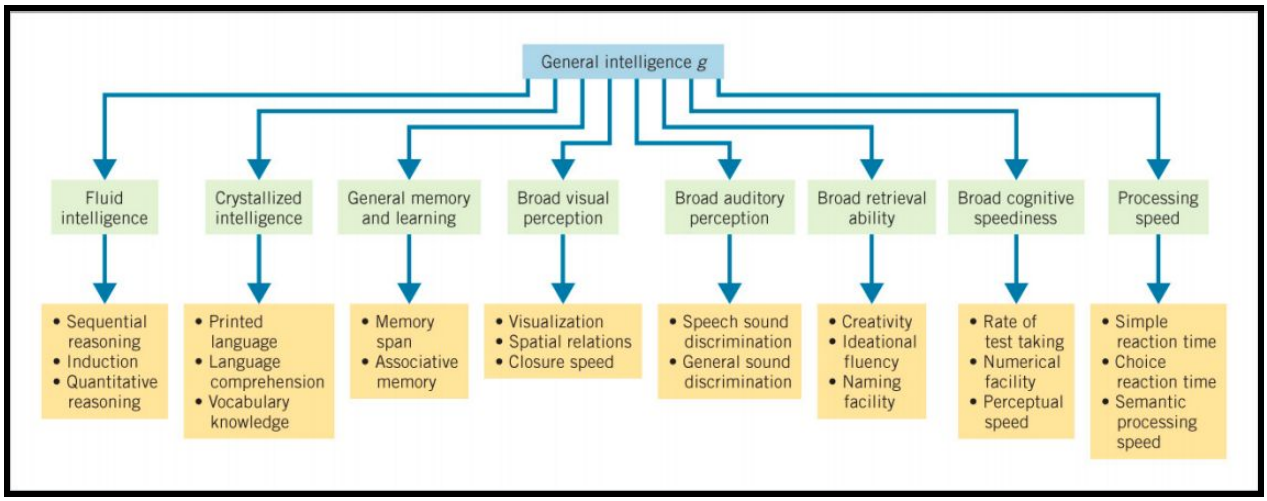
Lecture Notes:

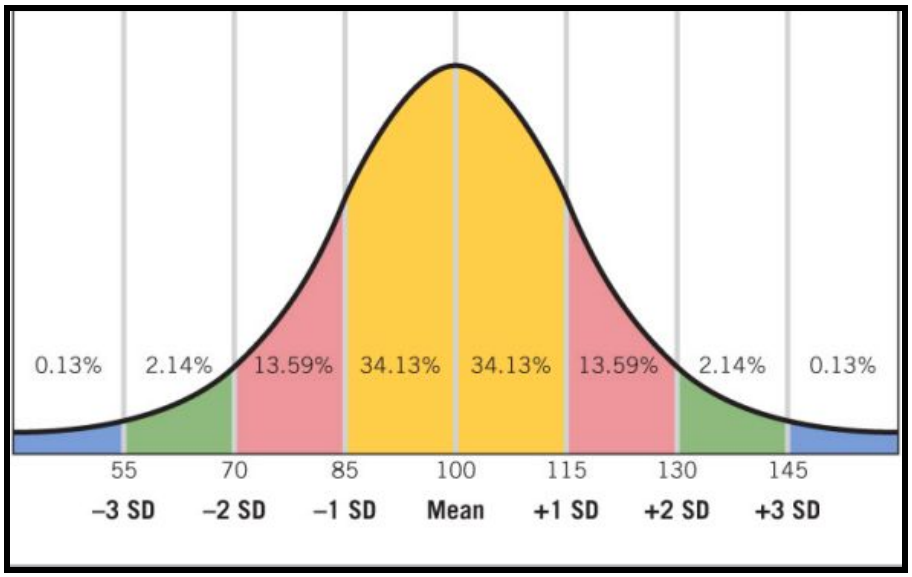
- Intelligence is:
  - The ability to learn or understand, or to deal with new or challenging situations.
  - The ability to apply knowledge to manipulate one's environment.
  - The ability to think abstractly as measured by objective criteria.
- Intelligence predicts academic success, economic success, occupational success and success on standardized tests.
- Half of intelligence comes from genetics and the other half comes from the environment.
- IQ scores are more similar between identical than between fraternal twins.
- IQ scores of adopted children are more similar to their biological parents'.
- Some environmental factors that affect intelligence are stress levels at home, a child's nutrition, and the education of their parents. Furthermore, IQ scores are positively correlated with protective factors (high parental involvement, stimulating physical environment, etc). IQ scores are negatively correlated with risk factors (low SES, low maternal education, etc).
- School improves children's intelligence. IQ scores are higher during the school year than in the summer. Kids that miss the academic year cutoff have lower IQ scores than slightly older kids that have made the cutoff.
- Intelligence has been defined in many different ways throughout human history. Some debunked views are keenness of sight and ethnicity. However, other older, valid scientific views, such as reaction time, speed of association and brain volume are still used.
- Carroll's three-tiered model of intelligence is derived from factor analysis. His 3-tiered model starts with **general intelligence**, abbreviated as **g**, on the top. At the second level, there is basic intelligence. These include **fluid intelligence**, **crystallized intelligence** and general memory and learning. The third level is a set of specific abilities. Carroll's 3-tiered model of intelligence looks like this:



- Linguistic, logical-math and spatial intelligence would correspond to some of the specific abilities in Carroll's three-tiered model, which are commonly tested on modern IQ tests.
- While we can't measure intelligence directly, we can measure its correlates.
- Alfred Binet invented the first IQ test using trial & error. This test is called the **Binet-Simon intelligence test**. To create the test, Binet got people who he knew and got them to do a series of tests involving puzzles, object naming and counting. He saw

which categories of tests successful people did well on and used that as a framework of measuring intelligence.

- Modern IQ tests are consistent with Carroll's three-tiered model. They test performance on a number of areas from the bottom tier, such as printed language, spatial relations, rate of test taking, semantic processing speed.
- Intelligence tests are different for different ages and different locations.
- IQ tests are created to produce a standard score in the age group and location in which they are presented. The mean score on IQ tests is designed to be 100 with a standard deviation of 15. IQ scores follow a normal distribution.



- How likely is it that a child will score a 130 or higher on an IQ test? Answer: About 2.27%
- **Percentile** is the percentage you expect to fall below you.
- What percentile is a child in if she scores a 115? Answer: The 84th percentile
- How does the average IQ score of a 9-year-old compare to the average IQ score of a 6-year-old? Answer: They should be the same.
- How does the average IQ score of a 10-year-old in Canada compare to the average IQ score of a 10- year-old in the United States? Answer: They should be the same.
- IQ tests suffer from problems of validity. Sometimes, IQ tests measure a person's language skills or cultural knowledge rather than intelligence.
- IQ tests' short-term reliability is good. However, their long-term reliability is less consistent. Infant IQ doesn't always reliably predict child/adult IQ. Child and adult IQ are correlated, but the correlation is lower with longer time intervals.
- IQ tests don't capture all forms of intelligence.
- In Gardner's theory of multiple intelligences, people have at least 7 types of intelligence necessary for functioning and survival. These 7 intelligences are not related to each other. Furthermore, they are not based on aptitude tests but are based on self-report measures and behavioural observation.
- There is evidence for Gardner's approach. First, these areas of intelligence have different developmental patterns (emerge at different ages). Second, damage to a specific brain area may impact only one type of intelligence and not others.
- The Flynn effect is that IQ scores have consistently risen around the world since we started measuring/testing IQ.

- The Flynn effect slope is steeper in low SES communities and in developing countries.

Textbook Notes:

- **Module 9.1 Measuring Intelligence:**
- **Intelligence and Perception Galton's Anthropometric Approach:**
- Galton believed that sensory abilities should be an indicator of a person's intelligence.
- **Anthropometrics** refers to methods of measuring physical and mental variation in humans.
- **Intelligence and Thinking The Stanford–Binet Test:**
- In contrast to Galton, Alfred Binet, argued that intelligence should be indicated by more complex thinking processes, such as memory, attention, and comprehension. This definition of **intelligence** is the ability to think, understand, reason, and adapt to or overcome obstacles.
- The **mental age** is the average intellectual ability score for children of a specific age. For example, if a 7-year-old's score was the same as the average score for 7-year-olds, she would have a mental age of 7, whereas if it was the same as the average score for 10-year-olds, she would have a mental age of 10, even though her chronological age would be 7 in both cases.
- The **Stanford-Binet test** is a test intended to measure innate levels of intelligence.
- **Intelligence quotient** or **IQ** is a measure of intelligence computed using a standardized test and calculated by taking a person's mental age, dividing it by his chronological age, and then multiplying by 100. One issue with measuring IQ is that because our intelligence stabilizes as we get older, but our age increases, our IQ decreases when it shouldn't. To get around this issue, the deviation IQ was created.
- The **deviation IQ** is calculated by comparing the person's test score with the average score for people of the same age.
- **The Wechsler Adult Intelligence Scale:**
- The **Wechsler Adult Intelligence Scale (WAIS)**, the most common intelligence test in use today for adolescents and adults, was developed by David Wechsler.
- The WAIS provides a single IQ score for each test taker—the Full Scale IQ—but also breaks intelligence into a General Ability Index (GAI) and a Cognitive Proficiency Index (CPI).
- The GAI is computed from scores on the Verbal Comprehension and Perceptual Reasoning indices. These measures tap into an individual's intellectual abilities, but without placing much emphasis on how fast he can solve problems and make decisions.
- The CPI is based on the Working Memory and Processing Speed subtests. It is included in the Full Scale IQ category because greater working memory capacity and processing speed allow more cognitive resources to be devoted to reasoning and solving problems.
- **Raven's Progressive Matrices:**
- One of the key problems with many intelligence tests, such as the Stanford-Binet test and the WAIS, is that questions often are biased to favour people from the test developer's culture or who primarily speak the test developer's language.
- In the 1930s, John Raven developed **Raven's Progressive Matrices**, an intelligence test that is based on pictures, not words, thus making it relatively unaffected by language or cultural background.
- **IQ Testing and the Eugenics Movement:**
- Forced sterilization was carried out in at least 30 states and two Canadian provinces, lasting for almost half a century. In Alberta, the Sexual Sterilization Act remained in force

until 1972, by which time more than 2800 people had undergone sterilization procedures in that province alone. New immigrants, the poor, Native people, and Black people were sterilized far more often than middle and upper class White people.

- **Problems with the Racial Superiority Interpretation:**
- Research has indicated that the IQ differences may be due to a process known as **stereotype threat**, which occurs when negative stereotypes about a group cause group members to underperform on ability tests.
- **Working the Scientific Literacy Model Beliefs about Intelligence:**
- Research has found that people seem to hold one of two theories about the nature of intelligence. They may hold an **entity theory**, the belief that intelligence is a fixed characteristic and relatively difficult or impossible to change; or they may hold an **incremental theory**, the belief that intelligence can be shaped by experiences, practice, and effort.
- **Module 9.2 Understanding Intelligence:**
- A **savant** is an individual with low mental capacity in most domains but extraordinary abilities in other specific areas such as music, mathematics, or art.
- **Intelligence as a Single, General Ability:**
- When we say someone is intelligent, we usually are implying they have a high level of generalized cognitive ability.
- There are many techniques to calculate correlations among multiple measures of mental abilities. One of these techniques, **factor analysis**, is a statistical technique that examines correlations between variables to find clusters of related variables, or "factors."
- **Spearman's General Intelligence:**
- Charles Spearman developed the general intelligence factor (abbreviated as "**g**"). A person's **general intelligence factor** represents their "mental energy," reflecting his belief that some people's brains are simply more "powerful" than others.
- General intelligence factor correlates quite highly with high school and university grades, job performance among other things.
- However, we should note that in addition to a generalized intelligence, people also possess a number of specific skills. Individual differences on these skills may explain some of the variability on intelligence tests that is not accounted for by g. Spearman chose the name "s" to represent this specific-level, skill-based intelligence. His two-factor theory of intelligence was therefore comprised of g and s, where g represents one's general, overarching intelligence, and s represents one's skill or ability level for a given task.
- In the intervening decades, there were several different theories of multiple intelligences. The first influential theory of multiple intelligences was created by Louis Thurstone, who examined scores of general intelligence tests using factor analysis, and found seven different clusters of what he termed primary mental abilities. Thurstone's seven factors were word fluency, verbal comprehension, numerical abilities, spatial visualization, memory, perceptual speed, and reasoning. He argued that there was no meaningful g, but that intelligence needed to be understood at the level of these primary mental abilities that functioned independently of each other.
- **Working the Scientific Literacy Model Testing for Fluid and Crystallized Intelligence:**
- **Fluid intelligence (Gf)** is a type of intelligence used in learning new information and solving new problems not based on knowledge the person already possesses. Tests of Gf involve problems such as pattern recognition and solving geometric puzzles.

- **Crystallized intelligence (Gc)** is a type of intelligence that draws upon past learning and experience. Tests of Gc involve problems such as tests of vocabulary and general knowledge.
- The distinction between fluid and crystallized intelligence is basically the difference between "figuring things out" and "knowing what to do from past experience."
- **Sternberg's Triarchic Theory of Intelligence:**
- Robert Sternberg developed the **triarchic theory of intelligence**, a theory that divides intelligence into three distinct types: analytical, practical, and creative.
- Analytical intelligence is "book smarts." It's the ability to reason logically through a problem and to find solutions.
- Practical intelligence is "street smarts." It's the ability to find solutions to real-world problems that are encountered in daily life, especially those that involve other people.
- Creative intelligence is the ability to generate new ideas and novel solutions to problems.
- **Gardner's Theory of Multiple Intelligences:**
- Gardner proposed a theory of **multiple intelligences**, a model claiming that there are nine different forms of intelligence, each independent from the others.
- Gardner's Proposed Forms of Intelligence:

Verbal/linguistic intelligence	The ability to read, write, and speak effectively
Logical/mathematical intelligence	The ability to think with numbers and use abstract thought; the ability to use logic or mathematical operations to solve problems
Visuospatial intelligence	The ability to create mental pictures, manipulate them in the imagination, and use them to solve problems
Bodily/kinesthetic intelligence	The ability to control body movements, to balance, and to sense how one's body is situated
Musical/rhythmical intelligence	The ability to produce and comprehend tonal and rhythmic patterns
Interpersonal intelligence	The ability to detect another person's emotional states, motives, and thoughts
Self/intrapersonal intelligence	Self-awareness; the ability to accurately judge one's own abilities, and identify one's own emotions and motives
Naturalist intelligence	The ability to recognize and identify processes in the natural world—plants, animals, and so on

Existential intelligence	The tendency and ability to ask questions about purpose in life and the meaning of human existence

- While on average males and females are equally intelligent, when multiple intelligences are considered, rather than overall IQ, a clear difference between the sexes does emerge. On average, females are better at verbal abilities, some memory tasks, and the ability to read people's basic emotions, whereas males have the advantage on visuospatial abilities, such as mentally rotating objects or aiming at objects.
- **Module 9.3 Biological, Environmental, and Behavioural Influences on Intelligence:**
- **The Genetics of Intelligence Twin and Adoption Studies:**
- Decades of such research have shown that genetic similarity contributes to intelligence test scores.
- The intelligence scores of identical twins correlate with each other at about .85 when they are raised in the same home, which is much higher than the correlation for fraternal twins. Even when identical twins are adopted and raised apart, their intelligence scores are still correlated at approximately .80, a very strong relationship.
- **The Heritability of Intelligence:**
- Overall, the heritability of intelligence is estimated to be between 40% and 80%.
- **Behavioural Genomics:**
- While twin and adoption studies show that some of the individual differences observed in intelligence scores can be attributed to genetic factors, these studies do not tell us which genes account for the differences. To answer that question, researchers use behavioural genomics, a technique that examines how specific genes interact with the environment to influence behaviours, including those related to intelligence.
- Overall, studies scanning the whole human genome show that intelligence levels can be predicted, to some degree, by the collection of genes that individuals inherit.
- One way of speeding the research up has been to develop ways of experimenting with genes directly, in order to see what they do. **Gene knockout (KO) studies** involve removing a specific gene and comparing the characteristics of animals with and without that gene.
- **Environmental Influences on Intelligence:**
- Research on the biological underpinnings of intelligence repeatedly emphasizes the importance of environmental factors. Furthermore, brain areas involved in intelligence are responsive to a wide variety of environmental factors.
- **Birth Order:**
- On average, the IQs of first-born children are about three points higher than those of second-born children and four points higher than those of third-born children. One reason for this is that older siblings end up tutoring and mentoring younger siblings, imparting the wisdom they have gained through experience on to their younger siblings. Although this may help the younger sibling, the act of teaching their knowledge benefits the older sibling more. The act of teaching requires the older sibling to rehearse previously remembered information and to reorganize it in a way that their younger sibling will understand. Teaching therefore leads to a deeper processing of the information, which, in turn, increases the likelihood that it will be remembered later.
- **Socioeconomic Status:**
- One of the most robust findings in the intelligence literature is that IQ correlates strongly with socioeconomic status.

- On average, children growing up in wealthy homes have higher IQs than those growing up in poverty.
- **Nutrition:**
- Evidence suggests that poor nutrition could have negative effects on intelligence. Research has shown that diets high in saturated fat quickly lead to sharp declines in cognitive functioning in both animal and human subjects while diets low in saturated fats and high in fruits, vegetables, fish, and whole grains are associated with higher cognitive functioning.
- **Stress:**
- Stress increases the amounts of stress hormones, such as cortisol, in our bodies, which in turn is related to poorer cognitive functioning. Furthermore, high levels of stress also interfere with working memory and the ability to persevere when faced with challenging tasks.
- The toxic effects of chronic stress show up in the brain as well, damaging the neural circuitry of the prefrontal cortex and hippocampus, which are critical for working memory and other cognitive abilities as well as for the consolidation and storage of long-term memories.
- In short, too much stress makes us not only less healthy, but can make us less intelligent as well.
- **The Flynn Effect: Is Everyone Getting Smarter?:**
- The **Flynn effect** refers to the steady population level increases in intelligence test scores over time.
- **Nootropic Drugs:**
- **Nootropic substances** are substances that are believed to beneficially affect intelligence. Nootropics can work through many different mechanisms, from increasing overall arousal and alertness, to changing the availability of certain neurotransmitters, to stimulating nerve growth in the brain.

Definitions:

- **Anthropometrics:** Methods of measuring physical and mental variation in humans.
- **Crystallized intelligence (Gc):** A type of intelligence that draws upon past learning and experience.
- **Deviation IQ:** Calculated by comparing a person's test score with the average score for people of the same age.
- **Entity theory:** The belief that intelligence is a fixed characteristic and relatively difficult (or impossible) to change.
- **Factor analysis:** A statistical technique that examines correlations between variables to find clusters of related variables, or "factors"; In personality analysis, grouping items that people respond to similarly; for instance, the terms friendly and warm.
- **Fluid intelligence (Gf):** A type of intelligence used in learning new information and solving new problems not based on knowledge the person already possesses.
- **Flynn effect:** The steady population level increases in intelligence test scores over time.
- **Gene knockout (KO) studies:** Involve removing a specific gene and comparing the characteristics of animals with and without that gene.
- **General intelligence factor (g):** A person's "mental energy," reflecting Spearman's belief that some people's brains are simply more "powerful" than others.
- **Incremental theory:** The belief that intelligence can be shaped by experiences, practice, and effort.

- **Intelligence:** The ability to think, understand, reason, and adapt to or overcome obstacles.
- **Intelligence quotient/IQ:** A measure of intelligence computed using a standardized test and calculated by taking a person's mental age, dividing it by his or her chronological age, and then multiplying by 100.
- **Mental age:** The average intellectual ability score for children of a specific age.
- **Multiple intelligences:** A model claiming that there are nine different forms of intelligence, each independent from the others.
- **Nootropic substances:** Substances that are believed to beneficially affect intelligence.
- **Raven's Progressive Matrices:** An intelligence test that is based on pictures, not words, thus making it relatively unaffected by language or cultural background.
- **Savant:** An individual with low mental capacity in most domains but extraordinary abilities in other specific areas such as music, mathematics, or art.
- **Stanford-Binet test:** A test intended to measure innate levels of intelligence.
- **Stereotype threat:** Occurs when negative stereotypes about a group cause group members to underperform on ability tests.
- **Triarchic theory of intelligence:** A theory that divides intelligence into three distinct types: analytical, practical, and creative.
- **Video deficit:** Young children do not learn very much from information presented on screens.
- **Wechsler Adult Intelligence Scale (WAIS):** The most common intelligence test in use today for adolescents and adults.