I. Introduction: Thinking, Language, and Intelligence

Cognition refers to the mental activities involved in acquiring, retaining, and using knowledge. Cognitive abilities, such as analyzing situations, solving problems, making decisions, and using language, are widely regarded as key dimensions of intelligence.

A. The Building Blocks of Thought: Mental Imagery and Concepts

Thinking involves manipulating mental representations of information in order to draw inferences and conclusions.

1. A mental image is a mental representation of objects or events that are not physically present.
   a. We tend to scan a mental image in much the same way that we visually scan an actual image. Sometimes, thinking involves the manipulation of mental images before we can arrive at an answer.
   b. The mental images we use in thinking are not like photographs. They are memories of visual images that are actively constructed and potentially subject to error.

   a. Imagining a face or place activated the same brain region that is activated when perceiving a face or place (the parahippocampal place area [PPA] in the case of place and the fusiform facial area [FFA] in the case of a face).
   b. Compared to imagining a face or place, actually perceiving a face or place evoked a stronger brain response.
   c. Because the brain responses between the two conditions were so distinctive, the researchers could determine what the participants were imagining—faces or places—simply from looking at the fMRI scans.

3. Concepts

A concept is a mental category of objects, events, or situations that share similar features or characteristics.

   a. A formal concept is a mental category that is formed by learning the rules or features that define it.
   b. A natural concept is a mental category formed as a result of everyday experience.
c. A **prototype** is the most typical instance of a particular concept.

d. Some researchers believe that we store memories of individual instances, called **exemplars**, of a concept.

II. Solving Problems and Making Decisions

**Problem solving** refers to thinking and behavior directed toward attaining a goal that is not readily available.

A. Problem-Solving Strategies

1. **Trial and Error: A Process of Elimination**

   **Trial and error** involves actually trying a variety of solutions and eliminating those that do not work.

2. **Algorithms: Guaranteed to Work**

   An **algorithm** involves following a step-by-step procedure or method that always produces the correct solution.

3. **Heuristics: Rules of Thumb**

   A **heuristic** involves following a general rule-of-thumb strategy to reduce the number of possible solutions to a problem.

   a. One common heuristic is to break a problem into a series of **subgoals**.

   b. Another heuristic involves working **backward** from the goal.

   c. **Flexibility** may be the key to successful problem solving.

4. **Insight and Intuition**

   **Insight** is the sudden realization of how a problem can be solved. **Intuition** means coming to a conclusion or making a judgment without conscious awareness of the thought processes involved. Bowers and colleagues have proposed a two-stage model of intuition:

   a. In the first stage, the **guiding stage**, you perceive a pattern in the information being considered, but not consciously.

   b. In the second stage, the **integrative stage**, a representation of the pattern becomes conscious, usually in the form of a hunch or hypothesis.

   c. Such hunches are likely to be accurate only in contexts in which you already have a broad base of knowledge and experience.

B. Obstacles to Solving Problems: Thinking Outside the Box
1. **Functional fixedness** is the tendency to view objects as functioning only in their usual or customary way.
2. **Mental set** is the tendency to persist in solving problems with solutions that have worked in the past.

C. Decision-Making Strategies
Different cognitive strategies are used when making decisions, depending on the type and number of options available to us.

1. The Single-Feature Model  
   With the *single-feature model*, you base your decision on a single feature. When the decision is a minor one, this model can be a good decision-making strategy.

2. The Additive Model  
   With the *additive model*, you first generate a list of the factors that are most important to you, then rate each alternative on each factor using an arbitrary scale, such as $-5$ to $+5$. Finally, you add up the ratings for each alternative.

3. The Elimination by Aspects Model  
   The *elimination by aspects model* requires that you evaluate all the alternatives one characteristic at a time, typically starting with the feature you consider most important.

4. Good decision makers adapt their strategy to the demands of the specific situation. If there are few choices and features to compare, people tend to use the additive model. When the decision is complex, people often use the elimination by aspects strategy to narrow the choices and the additive model to make a final decision.

D. Decisions Involving Uncertainty: Estimating the Probability of Events. We tend to rely on two rule-of-thumb strategies to help us estimate the likelihood of events.

1. The Availability Heuristic  
   The *availability heuristic* is a strategy in which the likelihood of an event is estimated on the basis of how readily available other instances of the event are in memory. The less accurately our memory of an event reflects the actual frequency of the event, the less accurate our estimate of the event’s likelihood will be.

2. The Representativeness Heuristic  
   The *representativeness heuristic* is a strategy in which the likelihood of an event is estimated by comparing how similar it
is to our prototype of the event. This strategy can produce faulty estimates if
a. we fail to consider possible variations from the prototype, or
b. we fail to consider the approximate number of prototypes that actually exist.

3. Critical Thinking: The Persistence of Unwarranted Beliefs
Four obstacles to logical thinking can account for much of the persistence of unwarranted beliefs in pseudosciences or other areas.
   a. The belief-bias effect occurs when people accept only the evidence that conforms to their beliefs, rejecting or ignoring any evidence that does not.
   b. Confirmation bias is the strong tendency to search for information or evidence that confirms a belief, while making little or no effort to search for information that might disprove the belief.
   c. The fallacy of positive instances is the tendency to remember uncommon events that seem to confirm our beliefs and to forget events that disconfirm our beliefs.
   d. The tendency to overestimate the rarity of events is referred to as the overestimation effect.

III. Language and Thought
Language is a system for combining arbitrary symbols to produce an infinite number of meaningful statements. Its purpose is to communicate.

A. The Characteristics of Language
   1. Language requires the use of symbols, which may be sounds, written words, or formalized gestures. Its purpose is to communicate.
   2. The connection between the symbol and its meaning is completely arbitrary, which gives language tremendous flexibility.
   3. The meaning of these symbols is shared by others who speak the same language.
   4. Language is a highly structured system that follows specific rules. Every language has its own unique syntax, or rules for combining words. The rules of language help determine the meaning that is being communicated.
   5. Language is creative, or generative. That is, you can generate an infinite number of new and different phrases and sentences.
6. Another important characteristic of human language is displacement—the ability to communicate meaningfully about ideas, objects, and activities that are not physically present.

B. How Language Influences Thinking
1. Language can influence thinking in several ways. You interpret words through the use of perception.
2. Using the masculine generic pronouns *he* and *his* influences people to mentally visualize a male, even when they “know” that *he* supposedly includes both men and women. Thus, using *he* to refer to both men and women in speech and writing tends to increase male bias.
3. Culture and Human Behavior: The Effect of Language on Perception The linguistic relativity hypothesis, or Whorfian hypothesis, argues that differences among languages cause differences in the thoughts of their speakers.
   a. Research does not support Whorf’s contention that language determines perception and the structure of thought.
   b. Research does support the idea that language can influence perception and thought.

C. Animal Communication: Can Animals Learn Language?
Clearly, animals communicate with one another, but are they capable of mastering language?
1. In the mid-1980s, researchers taught a *bonobo* chimpanzee (Matata) to press symbols on a computer keyboard. Through observation, but no formal training, her infant son (Kanzi) learned about 150 spoken English words and an elementary understanding of syntax. His language comprehension is roughly equivalent to that of a 21/2-year-old human infant.
2. Research with other species, including bottle-nosed dolphins and gray parrots, has produced evidence that nonprimates also can acquire limited aspects of language.
3. In the last decade, studies conducted under carefully controlled conditions have produced some compelling demonstrations of animal language learning.
4. Collectively, animal language research reflects an active area of psychological research referred to as animal cognition, or comparative cognition.
IV. Measuring Intelligence

The use of mental images and concepts, problem solving and decision making, and the use of language, all make up aspects of what we commonly call intelligence. Formally, intelligence is the global capacity to think rationally, act purposefully, and deal effectively with the environment.

A. The Development of Intelligence Tests

Intelligence tests attempt to measure general mental abilities rather than accumulated knowledge or aptitude for a specific subject or area.

1. Alfred Binet: Identifying Students Who Needed Special Help
   a. Alfred Binet was a French psychologist who, with the help of French psychiatrist Théodore Simon, devised a series of tests to measure different mental abilities.
   b. As conceived by Binet, mental age is a measure of intelligence in which an individual’s mental level is expressed in terms of the average abilities of a given age group.
   c. Binet did not believe that he was measuring an inborn or permanent level of intelligence. He believed that intelligence was too complex a quality to describe with a single number.

2. Lewis Terman and the Stanford–Binet Intelligence Test
   a. Lewis Terman was an American psychologist who translated and adapted the Binet-Simon intelligence test for use in the United States. His revision was called the Stanford-Binet Intelligence Scale.
   b. An intelligence quotient (IQ) was derived by dividing the individual’s mental age by the chronological age and multiplying the result by 100.

3. World War I and Group Intelligence Testing
   a. When the United States entered World War I in 1917, the U.S. military was faced with the task of quickly screening 2 million army recruits. The Army Alpha test was administered in writing, and the Army Beta test was administered orally to recruits and draftees who could not read.
   b. At the end of the war, these group intelligence tests were adapted for civilian use, quickly became widely used, and, in some cases, were used indiscriminately.

4. In Focus: Does a High IQ Score Predict Success in Life?
In 1921, Terman identified 1,500 California children with IQs above 140 and began a longitudinal research study to see how genius-level intelligence would affect the course of their lives.

a. These children tended to be socially well adjusted. They were taller, stronger, and healthier than average children and had fewer illnesses and accidents.

b. As adults (as a group) their incomes were very high, two-thirds graduated from college, and many became successful professionals.

c. Personality factors seemed to account for the difference in the level of accomplishment of the 100 most successful and the 100 least successful men. The most successful were more goal oriented, had greater perseverance, and had greater self confidence.

d. IQ scores reliably predict academic success, but success in school is no guarantee of success beyond school.

5. David Wechsler and the Wechsler Intelligence Scales

a. American psychologist David Wechsler developed the Wechsler Adult Intelligence Scale (WAIS), which was first published in 1955.

b. The WAIS had two advantages over the Stanford–Binet.

(1) It was specifically designed for adults, rather than for children.

(2) It provided scores on 11 subtests measuring different abilities. The subtest scores are grouped to provide an overall verbal score and an overall performance score.

c. The WAIS’s design reflected Wechsler’s belief that intelligence involves a variety of different mental abilities.

(1) The subtest scores proved to have practical and clinical value.

(2) Wechsler’s test provided an overall, global IQ score, but he changed the way that the IQ score was calculated—comparing an individual’s scores with the scores of others in the same general age group. The average score for a particular age group was statistically fixed at 100.
Revised in 1981 and again in 1997, the WAIS today is known as the WAIS-III and remains the most commonly administered intelligence test. Wechsler also developed two tests for children: the Wechsler Intelligence Scale for Children (WISC) and the Wechsler Preschool and Primary Scale of Intelligence (WPPSI).

B. Principles of Test Construction: What Makes a Good Test?

1. **Achievement tests** are designed to measure a person’s level of knowledge, skill, or accomplishment in a particular area.

2. **Aptitude tests** are designed to assess a person’s capacity to benefit from education or training. Their overall goal is to predict a person’s ability to learn certain types of information or perform certain skills.

3. The three basic requirements of good test design are standardization, reliability, and validity.
   a. **Standardization** is the administration of a test to a large, representative sample of people under uniform conditions for the purpose of establishing norms.
      (1) The scores of this group establish the norms, or the standards against which an individual score is compared and interpreted.
      (2) These norms closely follow the normal curve (normal distribution), a bell-shaped distribution of individual differences in a normal population in which most scores cluster around the average score.
   b. **Reliability** is the ability of a test to produce consistent results when administered on repeated occasions under similar conditions.
   c. **Validity** is the ability of a test to measure what it is intended to measure.

V. The Nature of Intelligence

There is considerable disagreement about the nature of intelligence, including how intelligence should best be defined.

A. Theories of Intelligence

Much of the controversy centers on two key issues: Is intelligence a single, general ability, or is it a cluster of different mental abilities? Should the definition of intelligence be restricted to the mental
abilities measured by IQ and other intelligence tests, or should intelligence be defined more broadly?

1. Charles Spearman: Intelligence Is a General Ability
   British psychologist Charles Spearman advanced the theory that a factor he called general intelligence, or the g factor, was responsible for people’s overall performance on tests of mental ability.

2. Louis L. Thurstone: Intelligence Is a Cluster of Abilities
   American psychologist Louis L. Thurstone believed that there were seven different “primary mental abilities,” each a relatively independent element of intelligence.

3. Howard Gardner: “Multiple Intelligences”
   Howard Gardner, a contemporary American psychologist, contends that there are “multiple intelligences”—eight independent intelligences—with each being defined within the context of a particular culture.

4. Robert Sternberg: Three Forms of Intelligence
   Robert Sternberg agrees with Gardner that intelligence is a much broader quality than is reflected in the narrow range of mental abilities measured by a conventional IQ test.
   a. Sternberg’s triarchic theory of intelligence emphasizes both the universal aspects of intelligent behavior and the importance of adapting to a particular social and cultural environment.
   b. Sternberg has proposed a different conception of intelligence, which he calls successful intelligence, which involves three distinct types of mental abilities: analytic, creative, and practical.
      (1) Analytic intelligence refers to the mental processes used in learning how to solve problems, such as picking a problem solving strategy and applying it.
      (2) Creative intelligence is the ability to deal with novel situations by drawing on existing skills and knowledge.
      (3) Practical intelligence involves the ability to adapt to the environment and often reflects what is commonly called “street smarts.”

5. In Focus: Neurodiversity: Beyond IQ
   IQ tests may not adequately measure intelligence in a variety of
individuals.

a. People who may have high IQs, yet experience one of the autism spectrum disorders, often have more trouble navigating everyday activities than people with lower IQ scores.
b. Individuals with autism, the most severe of these disorders, may exhibit communication difficulties, highly repetitive behaviors, social unresponsiveness, and highly restricted routines.
c. Children with Asperger’s syndrome may have normal language development but some degree of narrow interests and inflexible behavior.
d. A common assumption that individuals with autism have mental retardation, a condition where IQ is 70 or below, has little empirical evidence to support it.
e. It can also be difficult to accurately measure intelligence in individuals who lack the ability to communicate or who are not good at social interaction.

B. The Roles of Genetics and Environment in Determining Intelligence

Virtually all psychologists agree that both heredity and environment are important in determining intelligence level; however, the relative quantities of each continue to be debated.

1. What Is Known

a. Environmental factors influence which genes are switched on, or activated.
b. Individuals inherit a potential range for a trait, and environmental factors determine how close they come to realizing that genetic potential.
c. The genetic range of intellectual potential is influenced by many genes, not by a single gene.

2. Twin Studies: Sorting out the Influence of Genetics Versus Environment

a. The heredity–environment issue has been explored by comparing the IQ scores of individuals who are genetically related to different degrees:
   (1) **Identical twins** share exactly the same genes. Any dissimilarities between them must be due to environmental factors rather than to hereditary differences.
(2) Genetically, *fraternal twins* are like any other pair of siblings.
(3) The closer the genetic relationship, the more similar the IQ scores.
(4) Environmental influences are demonstrated by the fact that identical twins raised in different homes have different IQ scores, and genetically unrelated people raised in the same home have IQs that are much more similar than are those of two unrelated people from randomly selected homes.

b. Researchers have scientifically estimated **heritability**, which is the percentage of variation within a given population that is due to heredity.

c. The currently accepted heritability estimate for intelligence is about 50 percent for the general population; that is, about 50 percent of the difference in IQ scores within a given population is due to genetic factors. Remember that these estimates apply only to groups—not to specific individuals.

3. Group Differences in IQ Scores

a. Much controversy surrounds the differences in average IQ for different racial groups.

b. In early childhood, there are *no* significant differences in IQ among European American, Japanese, and Chinese schoolchildren, yet by middle school, Asian students tend to score much higher than American students on both math and reading tests. The difference seems to be due to their different educational systems.

c. The most controversy has been caused by the differences in average IQ scores between black and white Americans. As a group, black Americans once scored about 15 points lower than white Americans as a group; however, this gap has narrowed over the past few decades to 10 points or less.

d. Group differences do not predict *individual* differences in IQ scores. The range and degree of IQ variation *within* each group is much greater than the 10-point average difference *between* black Americans and white Americans.
4. Differences Within Groups Versus Differences Between Groups
   a. It is possible to estimate the degree of difference within a specific group that is due to heredity, but not the difference between groups that is due to heredity.
   b. A study by Sandra Scarr and Richard Weinberg explored the relationship between racial IQ differences and the environment in which children are raised. The researchers found that black children raised by high-SES white families had higher average IQ scores than the average scores of both black and white children. They concluded that IQ differences are due not to race but rather to the socioeconomic conditions and cultural values to which children are exposed.
   c. In a survey of intelligence test scores around the world, 14 nations were found to have shown significant gains in average IQ scores in just one generation. Such changes in a population can be accounted for only by environmental changes, because the amount of time is far too short for genetically influenced changes to have occurred.

C. Cross-Cultural Studies of Group Discrimination and IQ Differences. The effect of social discrimination on intelligence test scores has been shown in numerous cross-cultural studies.
   1. The average IQ is lower for members of a discriminated-against minority group, even when that group is not racially different from the dominant group.
   2. Culture and Human Behavior: How Stereotypes Undermine Performance
      a. According to psychologist Claude Steele, stereotype threat occurs when members of a particular group fear that they will be evaluated in terms of a negative stereotype about their group. This fear creates anxiety and doubt and lowers performance.
      b. Numerous studies show that performance on tests is surprisingly susceptible to stereotype threat.
      c. Simply having the test administrator say that a particular test is racially fair or gender-neutral has been shown to reduce the effects of stereotype threat.
   3. Are IQ Tests Culturally Biased?
a. If standardized intelligence tests reflect white, middle-class cultural knowledge and values, minority-group members might do poorly on the tests not because of lower intelligence but because of unfamiliarity with the white, middle-class culture.
b. It is generally recognized that it is virtually impossible to design a completely culture-free test. A test will tend to favor the people from the culture in which it was developed.
c. Cultural differences in test-taking behavior may also affect test performance. In addition, such cultural factors as motivation, attitudes toward test taking, and previous experiences with tests can affect performance and scores on tests.

VI. Application: A Workshop on Creativity
   A. Creativity can be defined as a group of cognitive processes used to generate useful, original, and novel ideas or solutions to problems.
   B. Suggestions for Enhancing Creativity
      1. Choose the goal of creativity.
      2. Reinforce creative behavior.
      4. Acquire relevant knowledge.
      5. Try different approaches.
      6. Exert effort and expect setbacks.