

Chapter in Review

1. The computational theory of mind, developed by cognitive scientist Jerry Fodor and others, holds that the mind functions in a manner loosely analogous to a computer. Cognitive scientists study mental activities involved in collecting, processing, storing, retrieving, and manipulating information. Cognition encompasses all mental activities and attributes concerned with information.
2. Thought is the active process of mentally manipulating or processing information to solve problems, make decisions, increase knowledge, or fantasize. Thinking is composed of two components: mental images (representations of information in visual form) and concepts (mental categories or groupings into which may be placed people, places, things, events, and ideas that share some common characteristics). Concepts may sometimes have fuzzy boundaries. Natural concepts have fuzzy boundaries. A prototype is a particular idea representative of any given natural concept.
3. Problems are obstacles that stand in the way of achieving a goal. We use thought to solve problems. There are four strategies for problem solving: trial and error, algorithms, heuristics, and insight. Trial and error works well if the options for possible solutions of a problem are relatively few. Algorithms are step-by-step “recipes” that can solve any problem of a specific type (e.g., mathematical formulas). Algorithms never fail, but they are in short supply when it comes to typical problems facing human beings. Heuristics are mental short-cuts that human beings automatically fall back on when making judgments and decisions under conditions of uncertainty. Heuristics are very fast and often accurate, but they can also seriously mislead. The availability heuristic helps people to judge how often something occurs or how likely it is to occur in the future. The representativeness heuristic consists of making rapid mental comparisons between a new person or thing needing explanation or categorization with various prototypes of categories until a “match” is found.
4. One type of situation in which the representativeness heuristic often misleads is when a person fails to take base rates into consideration when using the heuristic to make probability judgments. A base rate is a probability figure expressed in percentage that indicates the prevalence of something or how frequently it occurs.
5. Insight occurs when a person has reached an impasse in attempts to solve a problem and then suddenly and effortlessly arrives at a solution. Impasses are often reached as a result of fixation, and insight may occur if the person at an impasse changes the way he or she mentally represents the problem. Although some researchers deny that insight is a unique problem-solving experience, some neuroscientific evidence suggests that it is.
6. Creativity involves finding problems as well as solving them. Creativity is a complex set of behaviors generally involving originality, flexibility, and utility.
7. Cognitive biases are systematic distortions in thinking, memory, and perception. These biases can affect the accuracy of judgments and decisions. One such bias is the confirmation bias that is often considered the most prevalent and destructive of all problems with human reasoning. The confirmation bias has a number of facets, but primarily it is the tendency to pay more attention and accord more weight to evidence that confirms what we already believe—or even to seek such evidence out—while ignoring evidence that would disconfirm our beliefs. Belief persistence is a related

- bias that allows a person to resist changing a belief by playing down the relevance or credibility of disconfirming evidence.
8. The gambler's fallacy is a misperception of randomness that causes a person to believe that the likelihood of a random event is affected by events that precede it. The representativeness heuristic also may play a role in the experience of the gambler's fallacy.
 9. At least three principles characterize human language: generativity, recursion, and displacement. Generativity is the quality of language that allows a person to use the relatively small number of words and grammatical structures of a language to compose a theoretically infinite number of sentences expressing an infinite number of new thoughts and ideas. Recursion means that any sentence can be extended indefinitely by embedding clauses or phrases within or following it. Displacement means that people can converse about the past and future, about things that do not exist, things that exist in other places, or about abstractions.
 10. Languages may influence the way we think (linguistic relativity hypothesis), but they do not determine the way we think (the Sapir-Whorf hypothesis).
 11. Many researchers believe that the capacity for language is a special internal faculty constructed of innate, specialized neural and cognitive structures and "wiring." From this view, all languages possess a "universal grammar"—a basic structure of intrinsic rules that all languages share in common. The internal language faculty allows children to learn language effortlessly from a very early age, even though they are exposed to only a few of the words and constructions possible in the language of their culture. Noam Chomsky was the first researcher to describe a theory of universal grammar and the innate language faculty in detail. Some researchers (e.g., connectionists) deny the existence of the innate language faculty.
 12. Linguists are not generally interested in prescriptive grammar. They often claim that no native speaker uses truly bad grammar, or that speaker could not be understood. Such linguists point out that rules of grammar are arbitrary conventions that change with the times.
 13. Animals communicate, but they do not have language—if generativity, recursion, and displacement are included in the definition of language. Animal communication systems are closed-ended, rather than open-ended, as is human language. Extensive efforts to teach language to chimpanzees have resulted only in the teaching of limited vocabularies and virtually no grammatical structures—after decades of attempts. Some researchers have claimed to have found instances of understanding (but not using) grammar in trained chimpanzees, but this claim is controversial. Research among bonobos and chimpanzees suggests the possibility that language may have evolved from gestures rather than vocal utterances.
 14. There is no accepted definition of "intelligence," but the word is used in two general ways: it can refer to rational, problem-solving, human-like thought ("practical intelligence" or "street smarts"); and it can refer to an individual's general capacity to process complex information and perform well on a wide variety of mental and manual tasks ("book smarts"). General intelligence (g) is the technical term generally used to describe "book smarts." Tests of general intelligence measure the ease and speed with which a person should be able to learn new information, perceptual speed, verbal skills, and the ability to juggle mental concepts. These tests may also measure

math skills and manual dexterity. Charles Spearman first proposed the existence of *g* over 100 years ago, and he initiated the psychometric tradition that relies upon objective measurement of intelligence using standardized tests, such as IQ tests.

15. IQ (intelligence quotient) is the most commonly accepted statistic describing general intelligence. Although the true IQ statistic is no longer used, the term “IQ” is still used to describe statistical results of various tests that tap into *g*. Intelligence tests are sometimes accused of being meaningless, but IQ is a highly reliable and meaningful statistic that does not simply measure facts one has learned at school. IQ scores are the best single predictor of GPA, achievement test scores, the number of years a person remains in school, and the academic degree he or she receives. IQ is also related to job performance and even health and longevity. However, IQ is in no way the only factor predicting success in school and it is far from the best predictor of success on the job. Contrary to popular belief, IQ tests are not biased, if they are given to representatives of groups used to “norm” the test, and if the test is used to predict academic achievement—the primary purpose of IQ tests. However, IQ may not be an unbiased estimate of innate “intelligence,” because some groups have unequal access to experiences and resources that increase both IQ scoring and school performance.
16. The idea of multiple intelligences is an alternative to the single factor *g* as a way of measuring and thinking about intelligence. During Spearman’s time, Louis Thurstone argued that intelligence consisted of seven distinct mental abilities. He suggested that a person could be high on some of the abilities, while low on others. This contrasted with Spearman’s idea of the indifference of the indicator, which stated that a person’s scoring on any single mental ability could be used to predict that person’s score on any other. Howard Gardner believes that the idea of intelligence should be stretched to include musical or athletic ability, as well as the ability to understand emotions and motivations. Robert Sternberg’s triarchic theory of successful intelligence states that *g* only underlies certain mental abilities (analytical reasoning), while creative intelligence and practical intelligence describe equally important mental attributes.
17. Most theories of intelligence do incorporate the idea of *g*, and while all may not agree as to its significance, the evidence is overwhelming that *g* measures “something” important about intelligence and predicts a number of important things about how a person will perform in various situations. The three-stratum theory of John B. Carroll hypothesizes three levels of intelligence. At the bottom are 69 highly specific (narrow) abilities; in the middle are fluid intelligence (innate capacity for analytic and abstract reasoning) and crystallized intelligence (skills and knowledge acquired over time through experience). At the top is *g*, which is the underlying factor determining success in the two other levels.
18. Cognitive ability is determined by genetic inheritance and environmental experience. Averaged out, approximately 50 percent of the differences in IQ scores in most samples are due to genetic differences and 50 percent to environmental experience. However, the contribution of genes becomes more pronounced as a child grows older.

Section Summaries *How does the mind work?*

1. The computational theory of mind suggests that the mind works according to sets of universal rules and principles for processing and manipulating information.
2. Thinking is composed of forming mental images and concepts.
3. Natural concepts are concepts we are predisposed to learn because they are a part of our natural or social world. A particularly good example of a natural concept is known as a prototype of the concept.
4. Daniel Kahneman's two-system theory proposes that there exist two systems of thought, which he calls System 1 and System 2. System 1 is rapid, effortless, intuitive, and automatic. It is not under voluntary control. System 2 is slower, effortful, and demands concentration and attention.

How do we use thinking to solve problems?

1. Trial and error is the most basic problem-solving strategy; heuristics are “rules of thumb” that produce rapid decisions and judgments; algorithms are step-by-step sets of instructions that are generally infallible; insight is an “aha!” experience that happens after a person reaches an impasse in his or her attempts to solve a problem.
2. The availability heuristic helps people to judge how often something occurs or how likely it is to occur in the future. The representativeness heuristic involves making instantaneous comparisons of a new person or thing with prototypes of various categories until a “match” is found.
3. A base rate is the prevalence, or relative frequency of occurrence, of something in a population. Knowledge of base rates is essential for making judgments of the likelihood of some event.
4. Insight is a problem-solving process that occurs when a person has reached an impasse—but then a solution suddenly appears as if from nowhere.
5. Creativity cannot easily be defined, but it is likely a syndrome or complex set of behaviors that include originality, utility, and, frequently, flexibility.

How do biases affect decision making?

1. The confirmation bias is the tendency to actively seek out, or accord more weight to, information that confirms what we already believe.
2. Randomness should be expected to produce unlikely-seeming streaks over time (“chance is lumpy”). The gambler's fallacy is the false belief that the likelihood of a random event is affected by events that have preceded it.

Language: What is it, and how do we learn it?

1. Language is an open-ended code-like system of communication and expression built upon symbols and representations. Languages possess the properties of generativity, recursion, and displacement.
2. The term *language* also refers to a hypothesized internal language faculty made up of universal grammar—a set of intrinsic “rules” common to all languages. Not all linguists and cognitive scientists acknowledge the existence of the innate language faculty or universal grammar.

3. Language influences the way people perceive their world, but it does not fully determine perception as proposed in the original Sapir-Whorf hypothesis of linguistic determinism. The notion that language has an influence on the way people perceive their world is known as linguistic relativism.

Do nonhuman animals have language?

1. Animal communication systems are occasionally referential, but they lack generativity, recursion, and displacement.
2. Claims that apes can be taught human sign language have been challenged. However, some evidence suggests that apes might be able to be taught a limited vocabulary of signs and rudimentary understanding of syntax.
3. Recent evidence suggests that among chimpanzees and bonobos, hand and arm gestures are a more flexible method of communication than facial expressions and vocalizations.

What is intelligence?

1. The term *intelligence* has two general meanings: The first refers to the quality of rational “humanlike” thought—overcoming obstacles, solving problems, and making rational decisions. The second meaning is best summarized in the idea of general intelligence (*g*).
2. IQ began as a statistic that used a specific formula to compare a child’s performance on tests of mental abilities with the performance of other children of his or her age.
3. IQ measures not just “book learning” but people’s ability to learn the knowledge and skills that are presented to them by their environments.
4. IQ is an unbiased predictor of academic performance. However, it may be biased as a measure of innate ability. Moreover, IQ can only be said to measure “intelligence” if one defines intelligence in terms of *g*.
5. Robert J. Sternberg’s triarchic theory of successful intelligence proposes that there are three types of intelligence: analytic (comparable to *g*), creative, and practical.
6. John B. Carroll’s three-stratum theory of cognitive abilities is a hierarchical theory which proposes that intelligence consists of three strata, or levels, including 69 narrow (specific abilities), 8 broad mental abilities including fluid and crystallized intelligence, and *g* or general intelligence.

Where does intelligence come from?

1. Both genes and environments contribute to the development of individual differences in scoring on intelligence tests. On average, about 50 percent of differences between individuals in intelligence scoring are due to genetic differences, and 50 percent to environmental effects.
2. The contribution of genes to differences in scoring on intelligence tests becomes more pronounced as a child grows older, while the influence of environment becomes less pronounced. This is particularly true once a person reaches adulthood.