**Chapter 6: Memory**

**Encoding: Transforming Perceptions Into Memories**

* Encoding is the process of transforming the information received through our senses into a lasting memory.
* A new memory is made and automatically semantically encoded when new information mixes with old information that already has meaning to us.
* Semantic encoding is characterized by relating new information to previous knowledge in a meaningful way.
* Visual imagery encoding also relates new information to previous knowledge, but features both a visual and a verbal placeholder.
* Organizational encoding is a process of finding relationships between items to make them easier to retrieve.
* Encoding information with respect to its survival value is a particularly effective method for increasing subsequent recall, perhaps because our memory systems have evolved in a way that allows us to remember especially well information that is relevant to our survival, and perhaps because survival scenarios used in memory experiments draw on elements of semantic, visual imagery, and organizational encoding, as well as require extensive planning.

**Storage: Maintaining Memories Over Time**

* Because research participants could recall the same number of letters from any row of the grid, the iconic memory test suggests that sensory memory holds information for a second or two. “Rehearsal” helps keep memories in short-term storage, and “chunking” combines information into a single, meaningful item.
* Working memory is the active maintenance of information in short-term storage, where information is retained for about 15 to 20 seconds. A model of working memory describes the subsystems that store and manipulate visual and verbal information, the episodic buffer that integrates information, and the central executive that coordinates them.
* The hippocampus functions as an index to put information into long-term memory, but evidence from amnesiacs indicates that it is not the site of long-term memory storage.
* The act of recalling, thinking, and talking about a memory leads to consolidation. Sleep also is an important factor. However, when memories are retrieved, they may also become vulnerable to disruption.
* Memory storage depends on changes in synapses, and long-term potentiation (LTP) increases synaptic connections.

**Retrieval: Bringing Memories to Mind**

* Whether or not we remember a past experience depends on whether retrieval cues are available to trigger recall. Retrieval cues are effective when they are given in the same context as when we encoded an experience. Moods and inner states can become retrieval cues.
* Retrieving information from memory has consequences for later remembering. Retrieval improves subsequent memory of the retrieved information, as the benefits of testing on later recall show. However, fMRI evidence shows that regions of the frontal lobe involved with retrieving information also play a role in suppressing related information that is not retrieved. This finding underscores the importance of eyewitness interviews being as complete as possible.
* Research shows that retrieving and vividly reexperiencing memories of objects that were seen makes memory vulnerable to disruption, such that unseen objects may be wrongly incorporated into the memory.
* Retrieval can be separated into the effort we make while trying to remember what happened in the past, and the successful recovery of stored information. Neuroimaging studies suggest that trying to remember activates the left frontal lobe, whereas successful recovery of stored information activates the hippocampus and regions in the brain related to the sensory aspects of an experience.

**Forms of Long-Term Memory: More Than One Kind**

* Long-term memory consists of several different forms.
* Implicit memory refers to the unconscious influence of past experiences on later behavior and performance, such as procedural memory and priming. Procedural memory involves the acquisition of skills as a result of practice, and priming is a change in the ability to recognize or identify an object or a word as the result of past exposure to it. People who have amnesia are able to retain implicit memory, including procedural memory and priming, but they lack explicit memory.
* Explicit memory is the act of consciously or intentionally retrieving past experiences. Episodic memory is the collection of personal experiences from a particular time and place; it allows us both to recollect the past and imagine the future. Semantic memory is a networked, general, impersonal knowledge of facts, associations, and concepts.
* Collaborative memory refers to remembering in groups. Collaborative remembering can both impair memory (collaborative inhibition) and enhance it by exposing people to new information and helping to correct errors.

**Memory Failures: The Seven “Sins” of Memory**

* Memory’s mistakes can be classified into seven “sins.”
* Transience is reflected by a rapid decline in memory, followed by more gradual forgetting. With the passing of time, memory switches from detailed to general. Both decay and interference contribute to transience.
* Absentmindedness results from failures of attention, shallow encoding, and the influence of automatic behaviors; it is often associated with forgetting to do things in the future.
* Blocking occurs when stored information is temporarily inaccessible, as when information is on the “tip of the tongue.”
* Memory misattribution happens when we experience a sense of familiarity but don’t recall, or we mistakenly recall, the specifics of when and where an experience occurred. Misattribution can result in eyewitness misidentification or false recognition. Individuals suffering from frontal lobe damage are especially susceptible to false recognition.
* Suggestibility gives rise to implanted memories of small details or entire episodes. Suggestive techniques such as hypnosis or visualization can promote vivid recall of suggested events, and therapists’ use of suggestive techniques may be responsible for some individuals’ false memories of childhood traumas. Bias reflects the influence of current knowledge, beliefs, and feelings on memory of past experiences.
* Bias can lead us to make the past consistent with the present, to exaggerate changes between past and present, or to remember the past in a way that makes us look good.
* Persistence reflects the fact that emotional arousal generally leads to enhanced memory, whether we want to remember an experience or not. Persistence is partly attributable to the operation of hormonal systems influenced by the amygdala. Although each of the seven sins can cause trouble in our lives, each has an adaptive side as well.
* You can think of the seven “sins” as costs we pay for benefits that allow memory to work as well as it does most of the time.

**Chapter 7: Learning**

**What Is Learning?**

* Learning involves the acquisition of new knowledge, skills, and responses. It is based on experience and produces a change in the organism, and that change is relatively permanent.
* Even the simplest organisms exhibit simple forms of learning known as habituation and sensitization.

**Classical Conditioning: One Thing Leads to Another**

* Classical conditioning can be thought of as an exercise in pairing a neutral stimulus with a meaningful event or stimulus. Ivan Pavlov’s initial work paired a neutral tone (a conditioned stimulus, CS) with a meaningful act: the presentation of food to a hungry animal (an unconditioned stimulus, US). As he and others demonstrated, the pairing of a CS and a US during the acquisition phase of classical conditioning eventually allows the CS, all by itself, to elicit a response called a conditioned response (CR).
  + *In second-order conditioning, the CS can be paired with a new neutral stimulus to elicit a response.*
  + *The conditioned response will decline in a process called extinction if the CS is repeatedly presented without the US, although spontaneous recovery can occur after a rest period.*
  + *Conditioning generalizes to similar stimuli, which indicates an ability to discriminate between them.*
* Classical conditioning was embraced by behaviorists such as John B. Watson, who believed that higher-level functions, such as thinking or awareness, did not need to be invoked to understand behavior. Later researchers showed, however, that the underlying mechanism of classical conditioning is more complex (and more interesting) than the simple association between a CS and a US.
* Classical conditioning involves setting up expectations and is sensitive to the degree to which the CS is a genuine predictor of the US, indicating that classical conditioning can involve some degree of cognition. The cerebellum plays an important role in eyeblink conditioning, whereas the amygdala is important for fear conditioning.
* The evolutionary aspects of classical conditioning show that each species is biologically predisposed to acquire particular CS–US associations on the basis of its evolutionary history. In short, classical conditioning is not an arbitrary mechanism that merely forms associations. Rather, it is a sophisticated mechanism that evolved precisely because it has adaptive value.

**Operant Conditioning: Reinforcements from the Environment**

* Operant conditioning has at its root the law of effect and is a process by which behaviors are reinforced and therefore become more likely to occur. Positive and negative reinforcement increase the likelihood of behavior; positive and negative punishment decrease the likelihood of behavior.
  + *Secondary reinforcers can derive their effectiveness from associations with primary reinforcers.*
  + *Delayed reinforcement or punishment is less effective than immediate reinforcement or punishment.*
  + *Reinforcements occur only when the proper response has been made, but not every time, as evidenced by varying schedules of reinforcement.*
  + *Complex behaviors are shaped through reinforcement of successive steps*
* Like John B. Watson, B. F. Skinner tried to explain behavior without considering cognitive, neural, or evolutionary mechanisms. However, as with classical conditioning, this approach turned out to be incomplete.
  + *Operant conditioning has clear cognitive components: Organisms behave as though they have expectations about the outcomes of their actions and adjust their actions accordingly. Cognitive influences can sometimes override the trial-by-trial feedback that usually influences learning.*
  + *Studies with both animals and people highlight the operation of a neural reward center that affects learning.*
  + *The associative mechanisms that underlie operant conditioning have their roots in evolutionary biology. Some things are relatively easy to learn, whereas others are difficult; the history of the species is usually the best clue as to which will be which.*

**Observational Learning: Look at Me**

* Observational learning is based on cognitive mechanisms such as attention, perception, memory, and reasoning. But observational learning also has roots in evolutionary biology and for the most basic of reasons: It has survival value. Observational learning is an important process by which species gather information about the world around them.
* Observational learning has important social and cultural consequences because it appears to be well suited to transmission of novel behaviors across individuals.
* Chimpanzees and monkeys can benefit from observational learning, supporting the idea that each species evolved particular biological predispositions.
* The mirror neuron system becomes active during observational learning, and many of the same brain regions are active during both observation and performance of a skill. Observational learning is closely tied to parts of the brain that are involved in action.

**Implicit Learning: Under the Radar**

* In general, children are linguistically and socially sophisticated by age 6 or 7, but without awareness of how they have learned.
* Implicit learning is a process that detects, learns, and stores patterns without the application of explicit awareness by the learner. Simple behaviors such as habituation can reflect implicit learning, but complex behaviors, such as language use or socialization, can also be learned through an implicit process.
* Tasks that have been used to document implicit learning include artificial grammar and serial reaction time tasks.
* Implicit and explicit learning differ from each other in a number of ways: There are fewer individual differences in implicit than explicit learning; psychotic and amnesic patients with explicit learning problems can exhibit intact implicit learning; and neuroimaging studies indicate that implicit and explicit learning recruit different brain structures, sometimes in different ways.

**Learning in the Classroom**

* Research on learning techniques indicates that some popular study methods, such as highlighting, underlining, and rereading, have low utility, whereas other techniques, such as practice testing and distributed practice, have high utility.
* Practice testing improves retention and transfer of learning and can also enhance learning and reduce mind-wandering during lectures.
* Judgments of learning play a causal role in determining what material to study, but they can be misleading.

**Chapter 9: Language and Thought**

**Language and Communication: From Rules to Meaning**

* Human language is characterized by a complex organization—from phonemes to morphemes to phrases and finally to sentences.
* Children can distinguish between all contrasting sounds of human language, but they lose that ability within the first six months. Vocal babbling occurs at about 4 to 6 months, and first words are uttered or signed by 10 to 12 months. Sentences emerge around 24 months.
* Children acquire grammatical rules in development, even without being taught explicitly.
* The behaviorist explanation for language learning is based on operant conditioning, whereas nativists hold that humans are biologically predisposed to process language. Interactionists explain it as both a biological and a social process.

**Language Development and the Brain**

* Our abilities to produce and comprehend language depend on distinct but interacting regions of the brain, with Broca’s area critical for language production and Wernicke’s area critical for comprehension.
* Bilingual and monolingual children show similar rates of language development. Some bilingual children show greater executive control capacities, such as the ability to prioritize information and flexibly focus attention, but this finding has proven difficult to replicate in recent research. Bilinguals do tend to have a later onset of Alzheimer’s disease.
* Nonhuman primates can learn new vocabulary and construct simple sentences, but there are significant limitations on the size of their vocabularies and the grammatical complexity they can handle.

**Language and Thought: How Are They Related?**

* The linguistic relativity hypothesis maintains that language shapes the nature of thought.
* Recent studies on color processing point to an influence of language on thought.
* However, either language or thought may be impaired while the other is not, suggesting that language and thought are to some extent separate.

**Concepts and Categories: How We Think**

* We organize knowledge about objects, events, or other stimuli by creating concepts, prototypes, and exemplars.
* We acquire concepts using processes suggested by two theories: Prototype theory uses the most typical member of a category to assess new items; exemplar theory states that we compare new items with stored memories of other members of the category.
* Neuroimaging studies have shown that prototypes and exemplars are processed in different parts of the brain.
* Studies of people with cognitive and visual deficits have shown that the brain organizes concepts into distinct categories, such as living things and human-made things; the studies also suggest that visual experience is not necessary for the development of such categories.

**Decision Making: Rational and Otherwise**

* Human decision making often departs from a completely rational process. The mistakes that accompany this departure tell us a lot about how the human mind works.
* The values we place on outcomes weigh so heavily in our judgments that they sometimes overshadow objective evidence. When people are asked to make probability judgments, they will turn the problem into something they know how to solve, such as judging memory strength, judging similarity to prototypes, or estimating frequencies. This can lead to errors of judgment.
* When a problem fits our mental algorithms, we show considerable skill at making appropriate judgments. In making a judgment about the probability of an event, performance can vary dramatically.
* Because we feel that avoiding losses is more important than achieving gains, framing effects can affect our choices. Emotional information also strongly influences our decision making, even when we are not aware of it. Although this influence can lead us astray, it often is crucial for making decisions in everyday life.
* The prefrontal cortex plays an important role in decision making, and patients with prefrontal damage make more risky decisions than do non-brain-damaged individuals.

**Problem Solving: Working It Out**

* Like concept formation and decision making, problem solving is a process in which new inputs (in this case, problems) are interpreted in terms of old knowledge. Problems may be ill defined or well defined, leading to less obvious or more obvious solutions.
* The solutions we generate depend as much on the organization of our knowledge as on the objective characteristics of the problems we face. Means–ends analysis and analogical problem solving offer pathways to effective solutions, although we often frame things in terms of what we already know and already understand.
* Sometimes, as in the case of functional fixedness, that knowledge can restrict our problem-solving processes, making it difficult to reach solutions that should be easy to find.

**Reasoning: Truth and Validity**

* A fundamental distinction in human reasoning concerns the *truth* of statements and the *validity* of an argument. The success of human reasoning requires both true statements and valid arguments about them in order to reach sound conclusions.
* Belief bias describes a distortion of judgments about conclusions of arguments, causing people to focus on the believability of the conclusions rather than on the logical connections between the premises. This bias is exaggerated when people fail to inhibit pre-existing knowledge and beliefs.
* The illusory truth effect occurs when repeated exposure to a statement increases the likelihood that people will judge the statement to be true, even when it is false.
* Belief bias and the illusory truth effect both have potentially important real-world implications, as illustrated by how beliefs impact assessments of climate change and how exposure to fake news stories impacts assessment of their accuracy.