**Chapter 1: Introduction**

**Learning Objectives**

• Describe the scope of cognitive psychology and how it is related to cognitive science.

• Name and define the five core concepts of cognitive psychology.

• Explain how cognitive neuroscience informs the field of cognitive psychology.

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**Brief Summary**

Cognitive psychology is the study of human mental processes and their role in thinking, feeling, and behaving. The study of the mind has a long history in psychology dating back to its earliest schools of structuralism and functionalism. Throughout this time, interest in the scientific study of mental processes has evolved from inquiries into specific topics to a specific subfield of psychology, cognitive psychology, which espouses an interdisciplinary understanding of the mind.

Modern cognitive psychology is undergoing a shift in studying the mind from an information-processing approach to one rooted in techniques from neuroscience to uncover the neural basis of cognition. Topics such as mental representations, stages of processing, the parallel and serial natures of mental processing operations, the hierarchical structure of the mind, consciousness, and the bi-directional influence of emotion and cognition are now examined at the cortical level through the lens of physiological measuring instruments that can extract data from the previously unobservable domain of brain processes. As a result, modern-day cognitive researchers have an array of behavioral, physiological, and brain-manipulation techniques with which to provide converging evidence of the neural correlates of cognition.

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**Detailed Summary**

1. The beginnings of a scientific understanding of the human mind are taking shape in the fields of cognitive psychology and cognitive science. These fields connect with numerous areas of inquiry, as one would expect of a science of mental life. Cognitive psychology is the study of human mental processes and their role in thinking, feeling, and behaving. Cognitive science takes a mathematical perspective of the mind or brain as a computational device and draws insights and methods from psychology, biology, anthropology, linguistics, philosophy, and computer science.

2. Information must be mentally represented to be involved in perception, memory, or any other cognitive activity. It is through our mental representations that we know anything and everything. Mental representations are processed in stages such as encoding the information, storing it in memory, retrieving it when needed, and manipulating the information to arrive at a decision. Cognitive operations needed to, say, retrieve an item from memory may, in theory, occur in a series of steps or in parallel. Symbolic models and connectionist models are two alternative ways to describe the architecture of the information-processing system.

3. Consciousness is a core concept of cognitive psychology whose understanding does not stem from information-processing theory. It is necessary to distinguish between unconscious cognitive operations and those that give rise to the subjective qualities of consciousness. There are three senses in which the term *consciousness* is used in cognitive psychology. Self-knowledge means the capacity to represent the self mentally in addition to objects, events, and ideas. Information access means being aware of and able to report on mental representations and cognitive processes. Finally, sentience means the capacity for feelings and other subjective experiences.

4. The human brain may well be the most complex structure in the known universe, containing about 86 billion neurons with thousands of synapses to each neuron. The outer layer of the brain—the cerebral cortex—is symmetrically divided into two hemispheres. Within each hemisphere, the frontal, temporal, parietal, and occipital lobes are distinguished. Regions within these anatomical structures support specific cognitive functions, such as speech or face recognition. The limbic system lies beneath the cerebral cortex and is important in emotion, learning, and memory. The organization of the brain is highly parallel, with many separate streams of data being processed to support a single function, such as the recognition of an object in a spatial location.

5. Cognitive psychologists measure behavior that provides information about cognitive processes (e.g., verbal protocols of thinking aloud). They also measure physiological indicators of brain activity. Electrical and magnetic field activity of the brain can be measured with electroencephalography (EEG) and magnetic encephalography (MEG) and neuroimages (PET and fMRI). Lesions provide another way to study the cognitive functions served by the brain. A double dissociation refers to lesions in different locations that disrupt performance on Task A but spare performance on Task B and vice versa, respectively. Double dissociation suggests that the two brain regions damaged by the lesions support different cognitive functions, as measured by Tasks A and B.

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**Topical Outline**

Scope of Cognitive Psychology

* The study of cognition has been an important topic in psychology for more than a century and today, pervades all areas of psychology including neighboring sciences such as linguistics and anthropology.

Historical Perspective

* Early psychology was dominated by two schools of thought: structuralism and functionalism.
* In the early 20th century, a new school, behaviorism, emerged as a reaction to the earlier schools of thought and it eliminated mental processes as a topic of research.
* By the mid-1950s, an information-processing approach, based on digital computing, entered psychology and reinvigorated the study of mental processes.
* Modern-day cognitive psychology is moving away from an information-processing approach in favor of using cognitive neuroscientific techniques to examine the neural correlates of cognition.

Defining Cognitive Psychology

* Cognitive psychology is the study of human mental processes and their role in thinking, feeling, and behaving.
* Cognitive psychology assumes the mind and brain are systems that emerged through evolution and represents an interdisciplinary attempt to investigate issues of mind and brain.
* Cognitive psychology comprises eight critical areas of research: perception, learning, memory, knowledge representation, language, thinking, intelligence, and consciousness.

Core Concepts

Mental Representations

* Unobservable internal codes for information.

Stages of Processing

* The steps required to form, modify, and use mental representations in a cognitive task.

Serial Versus Parallel Processing

* Mental operations can occur in a serial fashion, one operation at a time in series, or in parallel fashion with multiple operations occurring at once.

Hierarchical Systems

* The components of the mind are arranged hierarchically in a cognitive architecture consisting of general purpose mechanisms that are highly interconnected with other cognitive systems and modules performing specialized functions set apart from other cognitive systems.
* Symbolic models assume that mental representations are processed serially in a symbolic fashion analogous to how a digital computer processes data.
* Connectionist models assume that mental representations are processed in parallel in a distributed fashion analogous to neural network processing.

Consciousness

* Consists of three capacities: mental representation of the self or self-knowledge, operating on mental representations or informational access, and subjective experience or sentience.

Emotion

* The heavy interconnectivity between the amygdala and the prefrontal cortex results in a bi-directional influence between the respective mental states they control, emotion and cognition.

The Brain

Cerebral Cortex

* Subdivided into the four lobes of the brain: Frontal, temporal, parietal, and occipital.

Parallel Processing

* A single cognitive function relies on the combined activity of multiple brain regions.

Research Methods

Behavioral Measures

* Includes reaction time or speed of response, proportion of errors made, and verbal protocols or tape recordings of people talking aloud while performing a task.

Physiological Measures

* Electrophysiology
  + Measurement of the time course of the brain’s electrical activity either during continuous recording (EEG) or when linked with the occurrence of a specific cognitive event (ERP).
* Neuroimaging
  + Measurement of the localization of neural activity generated during the performance of a cognitive task.
  + fMRI localizes neural activity by tracking changes in blood oxygenation levels
  + PET localizes neural activity by tracking changes in blood flow
  + Diffusion tensor imaging (DTI) uses diffusion of water molecules to mark the pathway of white-matter tracts within the brain.
  + The method of subtraction is used to isolate the cognitive activity associated with a particular area of the brain.

Experimental Manipulations

* Cognitive psychology relies on the manipulation of a task-related independent variable to derive its results. In cognitive neuroscience the experimental manipulation involves the brain and is accomplished through such techniques as brain lesions and transcranial magnetic stimulation.
* The objective of experimental manipulations of the brain is to identify a double dissociation or a situation where one cognitive function is served by a particular brain region, whereas a different function is served by another brain region.

Combining Techniques

* The golden triangle of cognitive research reflects the rationale that correlative evidence from three measurement domains (behavioral assessments, physiological measurements, and experimental manipulations) will provide convergent findings.
* Magnetoencephalography (MEG) is a physiological technique that combines electrophysiological recordings with high temporal resolution with the high spatial resolution of magnetic resonance imaging

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**Key Terms**

cognitive science

mental representation

stages of processing

serial processing

parallel processing

cognitive architecture

module

symbolic models

connectionist models

self-knowledge

informational access

sentience

frontal lobe

temporal lobe

parietal lobe

occipital lobe

hippocampus

reaction time

proportion of errors

verbal protocols

event-related potential (ERP)

positron emission tomography (PET)

functional magnetic resonance imaging

(fMRI)

diffusion tensor imaging (DTI)

method of subtraction

default network

double dissociation

transcranial magnetic stimulation (TMS)

magnetoencephalography (MEG)

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**Discussion Questions**

Discussion Question #1

Discuss the role that the study of cognition had in the emergence of psychology as a laboratory discipline. What role does cognitive psychology play in our modern understanding of cognition? How has the scientific understanding of cognition changed over the course of history?

Discussion Question #2

Review the 8 critical areas of research in Figure 1.1 and discuss how these areas are important for understanding problems in other subareas of psychology. How are these areas also important for disciplines outside of psychology? Why does cognitive psychology have such a strong potential for interdisciplinary collaboration?

Discussion Question #3

What role has technology played in the history of cognitive psychology? Why do you think technology is an important aspect of a field such as cognitive psychology?

Discussion Question #4

When setting goals for ourselves, we often develop a set of plans that enable us to reach our goals. How does the core concept of emotion figure into the cognitive planning that we do to achieve our goals?

Discussion Question #5

Philosophers have used the term *dualism* to describe how the mind and brain are distinct entities and separate from one another. How do cognitive psychologists characterize this relationship between the mind and the brain? In what ways are the mind and brain separate and in what ways are they integrated?

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**Questions for Thought**

Why is it important to understand the brain regions that mediate a given mental process, such as rehearsing silently the words or trigrams studied in Learning Activity 1.1? Can you validly infer such silent rehearsal took place from knowing the corresponding brain regions were active during studying and learning the list?

Behaviorism in the early to mid–twentieth century excluded mental representations and processes that could not be directly observed. How would you refute that position today? In what ways were the restrictions to observable behaviors still applicable and helpful in 21st century psychological science?

Symbolic models assume the mind works like a digital computer. Explain in what ways this is a valid comparison and in what ways it seems misleading.

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**Web Resources**

[**Transcranial Magnetic Stimulation**](http://www.jove.com/video/51735/transcranial-magnetic-stimulation-for-investigating-causal-brain)

A web video showing the set-up, running, and data analysis of an experiment in which transcranial magnetic stimulation is used to investigate the brain region involved in the phonological processing of words.

[**Theories and Hypotheses Related to Cognitive Architectures**](http://ai.eecs.umich.edu/cogarch0/common/theory.html)

A web page providing an overview of cognitive architectures and their relationship to results from fields such as cognitive psychology, cognitive science, and artificial intelligence.

[**Roots of Cognitive Psychology**](http://home.sandiego.edu/~taylor/coghist.html)

A history of cognitive psychology from its philosophical roots to modern cognitive science and connectionist theories.

[**Hitting a Nerve**](http://www.simonsfoundation.org/mathematics-and-physical-science/hitting-a-nerve/)

An overview of diffusion tensor imaging (DTI) and its relationship to magnetic resonance imaging (MRI).

[**Transcranial Magnetic Stimulation**](http://www.mayoclinic.org/transcranial-magnetic-stimulation/)

A description of the therapeutic application of transcranial magnetic stimulation to treat depression including a description of the procedure, the risks involved, and the factors influencing its effectiveness.

[**The Whole Brain Atlas**](http://www.med.harvard.edu/AANLIB/home.html)

An electronic and interactive whole brain atlas with views of the normal brain and brains that have been damaged by stroke, Alzheimer’s disease, and multiple sclerosis. It also includes a Neuroimaging Primer which provides examples of the various slice orientations and image types (e.g., MRI, CT, SPECT/PET).

[**ERPinfo**](http://erpinfo.org/)

A non-profit website that provides an introduction to the event-related potential (ERP) technique including links to ERP product reviews, open source software, and training workshops for beginning and intermediate researchers.

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**SAGE Journal Articles**

Gonsalves, B.D. & Cohen, N.J. (2010). [Brain imaging, cognitive processes, and brain networks](http://pps.sagepub.com/cgi/reprint/5/6/744?ijkey=tBWNZG55mQqv.&keytype=ref&siteid=sppps)*.* Perspectives on Psychological Science, 5, 744-752.

A critical look at how behavioral evidence and neuroimaging techniques can provide converging evidence about the structure and function of the mind and brain. Two specific examples from memory research are presented to illustrate this approach.

1. According to the authors, why are brain imaging methods likely to fail at localizing constructs such as greed or criminality?
2. How have brain imaging studies served to reveal the role of the posterior parietal cortex (PPC) in memory? What are the specific cognitive processes and component cognitive processes attributed to the PPC?
3. Using neuroimaging techniques, what are the different roles that have been identified for the prefrontal cortex (PFC) and the hippocampus in working memory?

Mantini, D. & Vanduffel W. (2013). [Emerging roles of the brain’s default network](http://nro.sagepub.com/cgi/reprint/19/1/76?ijkey=rMF6hYxq3S2bM&keytype=ref&siteid=spnro)*.* The Neuroscientist, 19, 76-87.

A review of the role of the brain’s default network in conscious experience. Specifically, an analysis of the behavioral evidence and physiological evidence underlying two theories for how consciousness functions: the internal mentation hypothesis and the sentinel hypothesis.

1. What behavioral evidence do the authors provide to support the internal mentation hypothesis? What areas of the brain’s default network are most active during spontaneous cognition?
2. What specific correlative evidence between behavioral and physiological measures of brain activity do the authors cite to provide support for the sentinel hypothesis?
3. How do the authors distinguish between core consciousness and extended consciousness? Which of these forms of consciousness is found in humans, but not in monkeys?
4. According to the authors, what is the relationship between the default network of the brain and consciousness? What evidence do the authors present to support this assertion?

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**Recommended Readings**

Beatty, J. (2001). *The human brain: Essentials of behavioral neuroscience.* Thousand Oaks, CA: Sage.

Buckner, R. L., Andrews-Hanna, J. R., & Schacter, D. L. (2008). The brain's default network: Anatomy, function, and relevance to disease. *Annals of the New York Academy of Sciences, 1124*, 1-38.

Damasio, A. R. (1999). *The feeling of what happens: Body and emotion in the making of consciousness.* Orlando, FL: Harcourt Brace.

Hilgard, E. R. (1980). Consciousness in contemporary psychology. *Annual Review of Psychology,* *31,* 1–26.

Lieberman, M. D. (2007). Social cognitive neuroscience: A review of core processes. *Annual Review of Psychology, 58*, 258-289.