**Chapter 2: Perception**

**Learning Objectives**

* Describe the role of the primary visual cortex in the occipital lobe in visual consciousness. Explain how blindsight contributes to understanding this role.
* Define the process of pattern recognition and explain the two kinds of agnosia that represent failures of this process.
* Explain the contributions of conceptually driven and data-driven processes in object recognition.
* Understand why distinctive features are only part of the answer to how we identify objects.

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**Brief Summary**

Perception involves the transduction of electromagnetic energy into a neural signal. The detection of objects in the environment is accomplished through pattern recognition or by matching the preliminary representations from perception with patterns stored in long-term memory. Neuropsychological disorders such as apperceptive agnosia and associative agnosia demonstrate the reliance of pattern recognition on, respectively, perceptual and semantic levels of analysis. Pattern recognition is, thus, conceptually-driven using top-down processes and data-driven using bottom-up processing. Examples of conceptually-driven processes include the word superiority effect and change blindness.

Modularity is the idea that specialized information processing occurs via a set of components that are automatic, fast, encapsulated apart from other cognitive systems, and instantiated in local areas of the brain. Face processing and speech processing may rely on modules to rapidly perform complex computations to engage in accurate perception.

**NOTE- If any of the links contained within are not working, please contact the publisher and an alternate resource will be found for you. In addition, an updated Chapter to this instructor’s manual will be uploaded to the companion website.**

**Chapter 2: Perception**

**Detailed Summary**

1. Perception begins with the transduction of the physical energy of a stimulus into an initial neural representation of the stimulus. As a result, the objects and events that are present in the environment are perceived, in the sense of being detected. With still more processing, the objects and events are recognized, in the sense of being categorized as meaningful. Visual consciousness depends on representations being processed in the visual cortex. Patients with blindsight lack any visual awareness but are able to guess accurately about the actual locations of objects in space.

2. The ability to perceive depends on pattern recognition—that is, categorizing objects and events detected in the environment by matching their preliminary representations with patterns stored in long-term memory. A stimulus can be perceived and understood in terms of its properties but not recognized as a meaningful object—a neuropsychological condition called agnosia. Patients suffering from lesions in certain regions of the brain can see objects but not recognize them at all. Apperceptive agnosia refers to a failure of pattern recognition caused by an inability to categorize objects at a perceptual level of analysis. Associative agnosia, by contrast, is caused by an inability to categorize objects at a functional semantic level of analysis.

3. Schemas generate expectations about the objects and events that will be encountered. These expectations direct exploration of the environment in the form of eye movements and other bodily movements that pick up the information available. The sampled information either confirms or modifies the original expectations, in turn leading to renewed exploration. Top-down or conceptually driven pattern recognition refers to the use of expectations to ease the process of finding a match between incoming stimuli and schemas that store our knowledge about the world in long-term memory. Bottom-up or data-driven pattern recognition refers to the use of the features picked up from the environment. Both data and expectations play a critical role in rapid, accurate, and adaptive perception.

4. The representation of objects in long-term memory has been viewed theoretically as feature lists and as structural descriptions. An object can be represented in terms of a list of distinctive features that discriminate it from other objects. The problem with this view is that two objects might include the same features but differ in terms of the relationships of their features. A structural description takes into account both the distinctive features and their relations.

5. Holistic processing refers to perceiving the whole object; analytic processing refers to perceiving the features that compose the whole. Perception of faces is unique in that it is more strongly influenced by holistic processing than by analytic processing. A specialized module is responsible for face perception. Face perception is automatic, fast, encapsulated from other cognitive systems, and instantiated in a localized area of the brain. Prosopagnosic patients suffering from damage to the module are unable to recognize faces despite intact object recognition in general.

6. Speech perception is challenging because the acoustic signal for the basic sounds of speech that communicate meaning—phonemes—is highly complex. Phonemes are coarticulated, meaning that each segment of the acoustic signal provides clues about the identity of more than one phoneme. As a consequence, the signal lacks an invariant feature for a particular phoneme that stays the same in all contexts. Speech signals are assigned to phonemes on the basis of well-defined categorical boundaries. Gradual variations in the acoustic signal are perceived categorically. Finally, the acoustic energy in speech is often continuous across word boundaries. The continuous speech stream is heard as separate words and phrases as a result of conceptually driven recognition processes*.*

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**Topical Outline**

Visual Consciousness

* The visual system constructs a mental representation of an object by transducing electromagnetic energy into a neural signal. The visual system is able to detect only a narrow band of electromagnetic energy ranging from 400-700 nanometers.

Visual Pathways

* The neural arrangement of the visual pathways results in a division of labor in vision so that objects in the left visual field are processed by the right hemisphere and those in the right visual field are processed by the left hemisphere.

Visual Cortex

* Vision without awareness as a result of lesions in the occipital cortex is known as blindsight. It demonstrates that visual consciousness relies on intact cortical structures in the visual cortex.

Pattern Recognition

* The process of categorizing objects and events detected in the environment by matching their preliminary representations with patterns stored in long-term memory.

Agnosia

* A failure of pattern recognition due to neuropsychological factors. Individuals with agnosia can perceive and understand stimuli in terms of their properties, but cannot meaningfully recognize such stimuli.
* Apperceptive agnosia, caused by damage to the posterior region of the right hemisphere, refers to a failure of pattern recognition due to an inability to categorize objects at the perceptual level of analysis.
* Associative agnosia, caused by damage to the left hemisphere, results in an inability to categorize objects at a functional level of semantic analysis.

Top-Down Versus Bottom-Up Processes

* Conceptually-driven processes operate from the top-down-from long-term memory to sensory memory-to identify the stimulus.
* Data-driven processes operate from the bottom-up-from sensory memory to long-term memory-to identify the stimulus.
* An example of conceptually-driven processes is the word superiority effect or the phenomenon that a single letter is recognized faster in the context of a whole word than when presented as an isolated letter.
* Change blindness or the phenomenon that people fail to notice large changes in visual scenes is due to conceptually-driven processes.

Object Representations

* Pattern recognition requires matching perceived information against perceptual representations stored in long-term memory.
  + Feature Detectors
    - The visual cortex is organized to detect the presence or absence of simple features suggesting that the mental representation of an object is composed of distinctive features.
  + Structural Descriptors
    - Pattern recognition is accomplished not just through feature analysis, but also through analysis of the relations among features.

Modularity

* Specialized information processing accomplished by a set of components that are automatic, fast, encapsulated apart from other cognitive systems, and instantiated in a localized area of the brain.
* Face processing and speech perception may rely on the operation of modules.

Holistic Versus Analytic Processing

* Holistic processing refers to perceiving the whole object; analytic processing refers to perceiving features that compose the whole.
* Face Perception
  + Perception of faces is more strongly influenced by holistic processing than by analytic processing.
  + Prosopagnosia is a selective inability to recognize faces that does not involve other kinds of vision difficulties.
  + Face perception is accomplished by a specialized module which relies on cortical structures such as the fusiform face area in the temporal cortex and the occipital face area in the inferior occipital cortex.
* Speech Perception
  + Relies on pattern recognition computations that make contact with a word stored in long-term memory from the auditory signal of spoken language.
  + Phonemes are speech sounds or phonological segments that make a difference in meaning.
  + A speech spectrogram represents the physical acoustic energy of an utterance by plotting frequency or hertz in cycles per second on the y-axis and time in milliseconds on the x-axis.
  + Phonemes are coarticulated, meaning that each segment of the acoustic signal provides clues about the identity of more than one phoneme.
  + The speech-processing module uses categorical perception to detect variations in the acoustic signal which mark a boundary between one phoneme and another.
  + The continuous speech stream is heard as separate words and phrases as a result of conceptually-driven recognition processes.

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**Key Terms**

blindsight

pattern recognition

apperceptive agnosia

associative agnosia

schema

conceptually driven processes

data-driven processes

word superiority effect

change blindness

distinctive features

holistic processing

analytic processing

prosopagnosia

phoneme

speech spectrogram

formants

coarticulation

categorical perception

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**Discussion Questions**

Discussion Question #1

Discuss how the process of sensation differs from perception. What is the contribution of cognitive processes to the constructive aspect of perception?

Discussion Question #2

List three occupations that rely on pattern recognition and explain how apperceptive agnosia and associative agnosia would affect performance in these occupations.

Discussion Question #3

Reading is a task that relies on both bottom-up and top-down processes. Children’s books are labeled according to the grade-level of reading proficiency. How is this labeling helpful in terms of bottom-up and top-down processes in reading?

Discussion Question #4

List the similarities and differences between the operation of the face perception module and the speech perception module. In what ways can facial stimuli and speech stimuli be altered to make perception more difficult? Which of these two categories of stimuli are more complex to process and why?

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**Questions for Thought**

In driving a car, it is necessary to identify numerous objects and traffic signs. Explain how conceptually driven pattern recognition helps to achieve this readily. In what circumstances are data-driven processes most important?

How does the categorical perception of speech contribute to the fast processing of phonemes by the speech-recognition module?

In what ways are apperceptive agonosia, associative agnosia, and prosopagnosia similar? Specifically, how do these three forms of agnosia differ?

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**Web Resources**

[**Optical Illusions & Visual Phenomena**](http://www.michaelbach.de/ot/index.html)

An interactive demonstration of the inverted face effect.

[**Moon Illusion**](http://www.michaelbach.de/ot/sze_moon/index.html)

An interactive demonstration of the moon illusion.

[**Malperception**](http://vectors.usc.edu/issues/4/malperception/agnosia_demo.html)

A simulation of the optic field of a visual agnostic.

[**Handwriting**](http://www.cs.toronto.edu/~graves/handwriting.html)

An interactive demonstration on handwriting legibility.

[**Types of Agnosias**](http://psych.ucalgary.ca/PACE/VA-Lab/Visual%20Agnosias/types%20of%20agnosias.html)

A web page featuring information about agnosia including a demonstration of the perceptual difficulties of apperceptive agnosia.

[**Prosopagnosia**](http://psych.ucalgary.ca/PACE/VA-Lab/Visual%20Agnosias/prosopagnosia.htm)

A web page on prosopagnosia including the cues prosopagnosics use to identify familiar people.

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**SAGE Journal Articles**

Behrmann, M. & Ewell, C. (2002).[Expertise in tactile pattern recognition](http://pss.sagepub.com/cgi/reprint/14/5/480?ijkey=p8scxuy3WHyJM&keytype=ref&siteid=sppss)*.* Psychological Science, 14, 480-486.

1. According to the authors, what is the *composite effect*? How is the composite effect related to the part-whole effect?
2. What is the primary difference in how information is represented in the visual and somatosensory systems?
3. What procedure did the authors use to train expertise in haptic pattern recognition?
4. Do the authors’ results demonstrate that expertise in haptic pattern recognition can be trained? If so, what specific finding demonstrates this development of expertise? What does it mean that haptic pattern recognition does not transfer to the visual domain?

Gazzaniga, M.S., Fendrich, R., & Wessinger, C.M. (1994). [Blindsight Reconsidered](http://cdp.sagepub.com/cgi/reprint/3/3/93?ijkey=YGDHByVRyy7Ps&keytype=ref&siteid=spcdp)*.* Current Directions in Psychological Science, 3, 93-96.

1. According to the authors, what are some issues that complicate the results obtained in the classic blindsight case of D.B.?
2. What do the authors mention as three important insights that are provided by the study of blindsight?
3. What do the authors believe to be the relationship between blindsight and conscious awareness? What role do they see for a secondary visual system in blindsight?

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**Recommended Readings**

Diehl, R. L., Lotto, A. J., Holt, L. L. (2004). Speech perception. *Annual Review of Psychology*, 55, 149-179.

Fodor, J. A. (1983). *The modularity of mind*. Cambridge, MA: MIT Press.

Henderson, J. M., & Hollingworth, A. (1999). High-level scene perception. *Annual Review of Psychology*, 50, 243-271.

Martin, A. (2007). The representation of object concepts in the brain. *Annual Review of Psychology, 58,* 25–45.

Palmer, S. E. (1999). *Vision Science: Photons to phenomenology*. Cambridge, MA: MIT Press.

Peissig, J. J. & Tarr, M. J. (2007). Visual object recognition: Do we know more now than we did 20 years ago? *Annual Review of Psychology*, 58, 75-96.