## CHAPTER 1: INTRODUCTION TO PERCEPTION

# Chapter Outline

1. Introduction
   1. Some Questions We Will Consider

1. Hypothetical “Science Project”: Design a Sensory Device

1. Why Read This Book?
2. The Perceptual Process
   1. But What About “Sensation”?
   2. Distal and Proximal Stimuli (Steps 1 and 2)
      1. Distal stimulus
      2. Principle of transformation
      3. Proximal stimulus
      4. Principle of representation
   3. Receptor Processes (Step 3)
      1. Sensory receptors
         1. Example: visual pigment
      2. Transduction

C. Neural Processing (Step 4)

1. Transmission
2. Change/Processing Signal
3. Primary receiving area
4. Cerebral Cortex
   1. Occipital lobe
   2. Temporal lobe
   3. Parietal lobe
   4. Frontal lobe

D. Behavioral Responses (Steps 5-7)

1. Perception
2. Recognition
   1. Problems of recognition: e.g., visual form agnosia
3. Action

E. Knowledge

1. Demonstration: perceiving a picture
   1. The “Rat-Man”
2. Categorize
3. Bottom-up (data-based) processing
4. Top-down (knowledge-based) processing
5. Studying the Perceptual Process
   1. The Two “Stimulus” Relationships (A and B)
      1. Stimulus-perception relationship
      2. Stimulus-physiology relationship
   2. The Physiology-Perception relationship
   3. Cognitive Influences on Perception

V. “Test Yourself 1.1”

VI. Measuring Perception

A. Gustav Fechner Introduces Methods to Measure Thresholds

* + 1. Classical Psychophysical Methods:
       - 1. Method of Limits

Absolute Threshold

Difference Threshold

* + - 1. Five Questions About the Perceptual World
         1. Question 1: What is the Perceptual Magnitude of a Stimulus? Technique: Magnitude Estimation
         2. Method: Magnitude Estimation
         3. Question 2; What is the Identity of a Stimulus? Technique: Recognition Testing
         4. Question 3: How Quickly Can I React to It? Technique: Reaction Time
         5. Question 4: How Can I Describe What Is Out There? Technique: Phenomenological Report
         6. Question 5: How Can I Interact With It? Technique: Physical Tasks and Judgments

VII. Something to Consider: Why is the Difference between Physical and Perceptual Important?

VIII. “Test Yourself 1.2”

IX. Think About It

X. Key Terms

# Learning Objectives

At the end of the chapter, the student should be able to:

1. State and explain each step of the perceptual process.
2. Differentiate between “top-down” and “bottom-up” processing.
3. Describe how cognitive processes can influence perception.
4. List five different ways to study perception.
5. Explain the concept of recognition and how it is distinct from perception.
6. Define “absolute threshold” and “difference threshold.”
7. Describe the methods used in method of limits and magnitude estimation studies.

# Chapter Overview/ Summary

Chapter 1 introduces the student to the basic concepts in perception. The opening vignette engages the student to think about perception as a science project: how you design a device to obtain information from the environment. This exercise reveals some of the major issues and complexities in perception. Next, four reasons for studying perception are outlined: (1) studying perception can result in a career: (2) applications of perception research overlap with other fields, such as medicine (e.g., treating dysfunctions of sensory systems), robotics, computer science, and engineering; (3) studying perception results in a greater appreciation of your sensory systems and enhances your curiosity about perceptual experiences; and (4) studying perception is inherently interesting. Goldstein then presents the steps of the “perceptual process”. These steps can be included in four categories: (1) Stimuli; (2) Receptor Processes; (3) Neural Processing; (4) Behavioral Responses. The role of Knowledge is also discussed in relation to the steps of the perceptual process. The process starts with the environmental stimulus, followed by the stimulus on the receptors (the “image” in vision. Stimulus processing continues with transduction (converting the physical energy into neural energy); transmission (receptors activating other neurons, which activate more neurons); and neural processing (the interactions between neurons and neural systems). Transduction is analogous to information transmission between an individual and an ATM. The steps categorized as “Behavioral Responses” are: perception (the conscious sensory experience); recognition (classifying objects into categories); and action (motor activities that occur to react to the sensory information. The “Knowledge” section highlights the influence of “top-down” cognitive processes on other steps in the perceptual process, as shown by the “rat-man” demonstration. The remainder of the chapter addresses how perception is studied. The approaches to studying perception are the psychophysical level of analysis (the stimulus-perception relationship) and the physiological approach (the stimulus-physiology relationship and the physiology-perception relationship). Both approaches are necessary to fully understand perception. Cognitive influences on perception are also vitally important to study. More specific ways of studying the psychophysical level of analysis are then detailed. These include detection/measuring thresholds; magnitude estimation, description (phenomenological method), and various behavioral methods (visual search, same-different judgments, distance judgments). Classical psychophysical methods for measuring detection are the method of limits, method of adjustment, and the method of constant stimuli (the latter two discussed in Appendix A). Using these methods, a researcher can determine the participant’s absolute threshold and difference threshold (DL). ’s law is the first psychophysical law discussed in Appendix B: the ratio of the DL to the standard stimulus is a constant fraction. Magnitude estimation is also discussed in more detail in Appendix C, including the major method used, representative results from stimuli in different modalities, and Stevens’s Power Law. Results from judging the brightness of a light indicate “response compression” (doubling the physical intensity of the light less than doubles the perceptual brightness of the light). Results from judging the intensity of an electric shock indicate “response expansion” (doubling the physical intensity of the shock more than doubles the perceptual response to the shock). Stevens’s Power Law specifies the relationship between the physical intensity and the perceptual experience. A key component of this law is that the physical stimulus intensity is raised to an exponent. This exponent is derived from the slope of the line created by taking the logarithm of the physical intensities and the logarithm of the magnitude estimations. The reason why it is a good thing for humans to have brightness show response compression, and electric shock show response expansion, is discussed. Appendix D introduces the idea of response criterion in a detection study, and how signal detection theory accounts for this.

# Demonstrations, Activities, and Lecture Topics

1. **Inherent Interest in Perception:** Encourage students to bring in examples of visual phenomena that they may have seen. Many students have had websites with illusions forwarded to them. Students may have 3-D magazines, books, or video games. I have an old box of Apple Jacks cereal that has numerous visual illusions on the back, and paper diner placemats with illusions. Emphasize the point that the ubiquity of these examples shows how inherently interesting perception is.
2. **Human Factors and Perception:** Goldstein cites applications of perception as one of the reasons for studying perception. A major contributor in this field is Donald Norman, the author of “The Psychology of Everyday Things” (1988), “Emotional Design” (2004), and “Living with Complexity” (2010). His JND (*Just Noticeable Difference*, a psychophysiological term related to difference thresholds) website has links to many of his essays and sample chapters (including “Attractive Things Work Better” from “Emotional Design” and “Memory is More Important than Actuality”). Two examples I like to use from “The Psychology of Everyday Things” are: (1) the beer-handle controls (Figure 4.6) to have visual and tactual discrimination of controls; and (2) the relatively well-known stove-top design and controls (Figures 3.3, 3.4 , and 3.5). The latter example shows the idea of natural mapping, which highlights the problem associated with the disputed “butterfly ballot” of the 2000 Presidential election. (Wikipedia provides a photo of the ballot and more information regarding its use in Florida). Goldstein also specifically mentions highway sign visibility. Don Meeker and James Montalbano have recently designed a new typeface for interstate highway signs; a slideshow of the development of this new typeface can be found at The New York Times website in a 2007 slideshow entitled “What’s Your Sign?”.
3. **“Do The Math” behind Stevens’s Power Law (Appendix C):** Give your students a concrete example of how Stevens’s Law works by plugging in actual values. To keep it simple, assume K=1. Then demonstrate response expansion by using n=3, and varying S from 2 to 8. Students will see how rapidly P increases. Then demonstrate response compression by using n=0.67 (or 2/3). This introduces the student to the wonderful world of fractional exponents, where you first square S, then take the cubed root of that quantity. Again, varying S from 2 to 8, the student will see that P does increase, but at a slower rate.
4. **Signal Detection Theory and “Phantom Vibration Syndrome”(Appendix D):** Signal detection theory is introduced in the “Something to Consider” segment of Chapter 1. Another way to initiate conversation about SDT is the phenomenon of “phantom vibration syndrome” (for example, a USA Today article from 2007 entitled “Good Vibrations? Bad? None at all?). Some people report that they feel their cell phone vibrating, only to find out that it isn’t. The simplest explanation would be in terms of the role of expectation in SDT. The Spokesman - Review, June 19th 2007, story “Phantom vibration syndrome” provides a few plausible explanations, one of which relates to differences in response criterion. In addition, a 2010 study published in BMJ - “Phantom vibration syndrome among medical staff: a cross sectional survey” - reports a 68% incidence rate of this phenomenon.
5. **Scavenger Hunt Icebreaker:**  This first-day activity can introduce the students to some major topics in perception, and introduce them to each other! In this type of scavenger hunt, which has been used as an icebreaker in various situations, the student is given a list of “characteristics” and must find someone else in the classroom that fits that characteristic. For example, the item might be “Has a dog or a cat,” and then the student finds a classmate who has a dog or cat. The key element here is to generate items that can be linked to the course. For example, the above item could be used to address the differences in perception between humans and other animals (“Are dogs colorblind?”; “How is a dog’s sense of smell different than humans?”). It can also help to add pop culture references: I included “Knows what was distinctive about Amanda Swafford on Cycle 3 *America’s Next Top Model*” (she was legally blind), or “Has seen the *U23D* movie.” I usually use about 12-14 items for the scavenger hunt in a class of 24-30 students.
6. **Classic Psychophysical Methods:** Students can get “hands-on” experience with classic psychophysical methods by being the experimenter and the participant with the right equipment. In order to demonstrate Weber’s weight lifting discrimination studies (Appendix B), Lafayette Instruments (ordering information can be found online) has “Discrimination Weights” (Model 16015). To measure two-point cutaneous sensitivity, Lafayette also has a Two Point Aesthesiometer (Model 16022). The advantage of using these devices is that the student/researcher can easily manipulate the stimulus intensities to present to a classmate, according to the psychophysical method being demonstrated.
7. **Blindfolds:** One key concept in a perception course is to not take your senses for granted. To demonstrate this point, you can bring in some blindfolds and ask for volunteers to wear them. It isn’t unusual to have no one volunteer, at which point you can discuss everyone’s reluctance to wear them. If you do have volunteers, let them wear the blindfolds and keep the class quiet for about two minutes. Then have the volunteers take the blindfolds off, and report their reactions to the experience.
8. **Method of Adjustment/ Social Psychophysics (Appendix A):** Wally Beagley developed the EyeLines software for doing method of adjustment experiments. This free software can introduce students to this classic psychophysical method. One way to use this software to highlight a key concept in Chapter 1 is to do a magnitude estimation task that demonstrates Stevens’s idea of social psychophysics. Stevens, in his book “Psychophysics: An Introduction to its Perceptual, Neural, and Social Prospects” (1975), believes that magnitude estimation can be used to scale attitudes, such as watch preferences or attitudes to crimes or monarchs. Based on Exercise #28 in “Workshops in Perception” by Power, Hausfeld, and Gorta (1981), you can use EyeLines to have students estimate how happy they would be to receive various money amounts. It is fairly simple to program EyeLines to present a range of money amounts to the student, and the student then uses the mouse to draw a line that reflects how happy he/she would be to win that amount of money: the longer the line drawn, the happier he/she would be with that money amount. The results can be discussed in terms of response compression or expansion. This also introduces the student to the concept of cross-modal matching in magnitude estimation.

# Suggested Websites

**Classics in the History of Psychology - Fechner**

Christopher Green has created a great website for the history of psychology. The contents of Fechner’s “Elements of Psychophysics”: Sections VII and XIV are particularly relevant for Chapter 1.

**The ISP web site: History of Psychophysics**

This is the website for the International Society for Psychophysics. There is information about the society, but the “History” link has a wealth of information about the history of psychophysics, including a “psychophysics family tree.”

**Donald Norman’s JND website**

This is Donald Norman’s “just noticeable difference” website. Explore the site for examples of human factors and perception as well as career options in human-centered design.

**Human Factors and Ergonomics Society**

This is the website of the Human Factors and Ergonomics Society. Interested students can find out more about opportunities and research in human factors.

**Cool Optical Illusions**

This is one of the “fun” websites to introduce the students to visual illusions. Higher-level websites with a greater amount of content will be given in later chapters, but this may be a good starting point.

**Wikipedia: Spinning Dancer Illusion**

Another illusion that students may be familiar with is the “spinning dancer” silhouette. This illusion is quite robust, and immediately piques student interest in perception. Even though this illusion would be covered more thoroughly when discussing depth ambiguities, it is a nice introductory illusion to generate interest.

**Movie Scene: *Spider-Man* (2002)**

(Scene 7 – “Fight with Flash):Prior to this scene, Peter Parker (portrayed by Tobey Maguire) has been bitten by a spider that will turn him into Spiderman, and is just realizing that he is undergoing changes. He has inadvertently splashed food all over Flash (Joe Manganiello), the class bully. The scene begins with Flash chasing after Peter, and then they confront each other. Peter is able to use his enhanced visual abilities (and other new powers) to defeat Flash, and hopefully impress Mary Jane (Kirsten Dunst). You can relate the scene to the text in relation to the reasons for studying perception: Not only is it important to maintain the sensory capabilities that you have, but heightened senses would greatly benefit any individual. (This, of course, is also the central idea behind many superheroes, and the police officer on the TV shows *The Sentinel* and *Bionic Woman*).