
Chapter 1: Introduction to Cognitive Psychology
Chapter 2: Cognitive Neuroscience

Ch 1: Introduction to Cognitive Psychology,

1. What was Donder's attempting to achieve when he invented the method of subtraction¹ in his study of simple and choice reaction time? Why is his work important for the development of cognitive psychology?

2. What is the measure of "savings" in Ebbinghaus's studies of memory? Why is it reasonable to interpret savings as a measure of how much a person remembers from prior learning? What was Ebbinghaus attempting to achieve when he invented the method of savings?

3. The concept of "unconscious inference" was discussed in lecture in connection with the history of cognitive psychology. Although the history of cognitive psychology is discussed in Goldstein Chapter 1, but unconscious inference is not discussed in this chapter. Rather, unconscious inference is discussed in Goldstein's Perception Chapter 3, pp. 63-64. Nevertheless, you might consider here, (a) what is meant by an "unconscious inference"?; and (b) why is this concept important for cognitive psychology?

4. The behaviorists made some strong assumptions about what distinguishes scientific from unscientific approaches to psychology. What were the main assumptions?
   • What aspect or aspects of modern cognitive psychology would seem unscientific from the behaviorist perspective?
   • Why was it difficult to investigate cognitive psychology within the behaviorist theoretical framework?

5. List some of the factors that lead to the diminished influence of behaviorist approaches in psychology, and to the rise of cognitive psychology in the late 1950's and 1960's. For example, why did use of computers in psychology help to promote a more cognitive approach to psychology? Why did developments in linguistics favor a more cognitive approach to psychology?

¹ The name, "method of subtraction," was not used in the textbook (pp. 6 - 7) to describe Donder's method, but it was used in the lecture, and also in the information processing literature.
6. For each of the following scientists, identify the year that is closest to the period in which they made contributions to psychology, and give one example of a contribution that each made to psychology:

   - Broadbent, Donald
   - Donders, Franciscus
   - Aristotle
   - Helmholtz, Hermann von
   - Newell, & Simon (first names, Allen and Herbert, respectively)
   - Watson, John
   - Ebbinghaus, Hermann
   - Skinner, B. F.

   (a) 350 BC
   (b) 1880 AD
   (c) 1915 AD
   (d) 1940 AD
   (e) 1960 AD

7. What are some examples of cognitive processes?
   - E.g., attention to scenes and objects;
   - E.g., processes that underly the production or comprehension of language.
   - Can you give other examples?

8. Figure 1.9a (p. 13) shows a flow diagram for a computer program. Figure 1.9b shows the outline of a process model of attention. (This is a flow diagram for Broadbent's filter model of attention.) Figure 1.16 shows an analogous flow model of memory; the questions asked in (a), (b) and (c) would apply to either flow diagram.

   (a) How do these diagrams help you to quickly grasp the general structure of an information process?

   (b) What aspect of human attention is completely ignored in this process model?

   Hint for part (b) - does the model in Figure 1.9b tell us what brain structures play an important role in memory? Does this model tell us what neural activity occur during the formation of memories or the retrieval of memories? Does this model describe how the filter blocks some inputs while allowing one input to pass through. Is it helpful to have a picture of the general structure of an information process that omits many details?

   (c) How did the proposal of the model in Figure 1.9b contribute to a scientific understanding of attention? How does the diagram of a model, like the one in Figure 1.9b, help psychologists understand the cognitive processes involved in attention?

9. Sian Beilock's studies of "choking under pressure" (pp. 16 - 17) are very interesting but they are more directly related to the topic of working memory (Chapter 5). For now, can you state in a general way why some people are more likely to choke under pressure?

**Ch 2: Cognitive Neuroscience**

1. Each of the following is an important component of a neuron or of the connection between neurons. Fill in the blanks in the spelling, and briefly describe what is the function of this component?

   - a_on
   - d_dr_

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2 We never discussed explicitly the contributions that Aristotle made to psychology, but he developed many of the ideas that continue to be actively studied in psychology, e.g., (i) epistemology as the study of the structure of knowledge; (ii) logic as the pattern of valid inference; (iii) concepts as organizing processes in thought; and many other contributions.
2. What does it mean to say that neuron A excites neuron C, or that neuron B inhibits neuron C?
   * What is an excitatory neurotransmitter or an inhibitory neurotransmitter?

3. What does it mean to say that a retinal ganglion cell has a center-on/surround-off or center-off/surround-on receptive field?
   * Explain how these types of ganglion cells can combine their outputs to create edge detectors or bar detectors in visual cortex.
   * Related Questions: What are "feature detectors" in visual perception? Can you give an example of a feature detector whose properties have been investigated means of single-cell recordings?

4. What is meant by the "neural code" for an object or an experience?
   * Chapter 2 (pp. 35-38) defines three related concepts: "specificity coding", "population coding" and "sparse coding". Can you define them without looking up the definitions in the textbook?
   * Chapter 2 (p. 37-38) discusses a patient who appeared to have a single neuron that appeared to respond selectively to different views of the actor, Steven Carell. Quiroga et al. (2008) proposed that this was indicative of sparse coding.
   * It should be mentioned that the subject of the study was a patient with epilepsy who was being prepared for brain surgery. The opportunity to measure single-cell recordings only lasted as long as it took map brain functions that were close to the target area for the surgery. Therefore the researchers could not spend a great deal of time (a) exploring how many different images of people (or even objects) would or would not trigger the firing of this cell, nor (b) exploring a large number of cells to see if they exhibited similar behavior. Therefore, although the findings superficially seem to show that this single cell was specific to images of Steven Carell, it could be that the cell actually responded to a broader range of stimuli, e.g., middle-aged white male American comedians, or that it was part of a small sparse coding network where the other cells in the network simply were not tested.

5. What is lateral inhibition? What is the role of lateral inhibition in the perception of visual patterns?

6. What is meant by "localization of function" (in brain functions)?
   * Can you give examples of localized functions in the brain?
   * Give neuropsychological evidence that at least some functions are localized in the brain.

7. Describe the sequence of events that occur when an fMRI image is made of brain activity. For example, suppose that we want to create an fMRI image of brain activity in the fusiform face area (FFA) when a person is viewing a human face. Suppose, also, that we plan to contrast this image with an image of brain activity when a person is viewing an open landscape like a field of flowers or a large lake.
   * Starting with the face stimuli, what does the fMRI record as a person views a series of faces? Describe in general how brain activity in the FFA responds to the task of viewing faces. Of course, there are many details that you don't know about - I mainly want to know what happens in the brain that the fMRI is able to measure. The main question is, what is fMRI measuring?
   * How is an fMRI image created that contrasts the brain activity while viewing faces with the brain activity while viewing open landscapes?

8. Briefly describe what aspect of brain activity is measured by each of the following methods:
   * (i) Single cell recordings (of electrical activity)
   * (ii) Event related potentials (ERPs)
(iii) Functional magnetic resonance imaging (fMRI)

Suppose that we are using one of these methods to measure brain activity following presentation of a visual stimulus. Discuss the strengths and weaknesses of these methods with respect to the following three issues:

(a) Spatial resolution, i.e., determining exactly where in the brain the activity is occurring.
(b) Temporal resolution, i.e., determining exactly when the brain activity is occurring. For example, is the peak level of activity reached at 350 milliseconds (ms) following the stimulus presentation, or at 380 ms following the stimulus presentation?
(c) Breadth of coverage, i.e., is the method sensitive to the activity across thousands of neurons, or is it only sensitive to a few (less than 50) neurons at any given time.

HINT:

9. What is meant by a double dissociation in the brain activity that is associated with performance on different tasks or the processing of different stimuli?

• Double dissociation is defined in Goldstein Chapter 2 (p. 40) in terms of functional impairments that result from damage to different areas of the brain. This definition is perfectly fine, but you should be aware that double dissociations can also be detected by means of behavioral or neuroimaging measurements in a non-clinical population. The study discussed in the next bullet point is an example of a double dissociation that can be demonstrated in normal subjects (not clinical patients with cognitive impairments).

• Chapter 2 (pp. 42-43) briefly discusses an fMRI study that demonstrated a double dissociation between the processing of indoor and outdoor scenes and the processing of human faces. This study was discussed in greater detail in lecture. Images of scenes produce increased brain activity, detected by fMRI, in the parahippocampal place area (PPA) but not in the fusiform face area (FFA). Images of human faces produce increased brain activity in the FFA but not in the PPA. What aspect of the research results justify the claim that face perception and place perception exhibit a double dissociation between the FFA and PPA?

* This study can be used to support the localization of function (scene perception or face perception) in the PPA and FFA, respectively. It also demonstrates the role of double dissociation in constructing a strong argument in favor of localization of function.

• Why is a double dissociation regarded as stronger evidence for the determination of the function of a brain area than a single dissociation?

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1 fMRI has good spatial resolution but poor temporal resolution. What does this mean?
ERP's have good temporal resolution but poor spatial resolution. What does this mean?
Single cell recordings have excellent temporal and spatial resolution, but they also have limitations. What are they?