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Chapter: Chapter 1: Essay

Essay

1. Describe five distal stimuli and their associated proximal stimuli that one experiences in the environment. No two stimuli should have the same perceptual dimension. For each of these distal stimuli, discuss the top-down information used in perceiving it.

Ans: Answers should first relate sensory experience (visual, auditory, olfactory, etc.) to the physical objects (or, distal stimuli) in the environment, and then show how knowledge and expectations of an observer lead to perception of the stimuli.

2. Describe three activities in which one uses three different senses to detect small differences in the intensity of sensory stimuli. What role does difference threshold play in each activity?

Ans: Cooking can be taken as an example here because one needs to adjust seasonings based on the perception of taste. Similarly, proper functioning of a mechanical device (car, air conditioner, etc.) can be detected based on the sound it makes. In the same way, an observer's like or dislike for a painting depends on his or her visual perception. The minimum difference between two stimuli that allows an observer to perceive that the two stimuli are different is known as a difference threshold. In all these cases, difference threshold helps an observer to differentiate between any two given stimuli.

3. Compare the advantages and disadvantages of the method of adjustment, the method of constant stimuli, and the staircase method in determining absolute threshold.

Ans: The method of adjustment is the simplest method for estimating absolute thresholds. In this method, a person observes the stimulus and manipulates a control that directly adjusts the intensity of the stimulus. The results tend to vary quite a bit, even when the method is used repeatedly with the same person. When compared with the method of adjustment, the method of constant stimuli provides more reliable results. It isn't very efficient because it involves repeated presentations of stimuli that are already known to be well below or well above threshold. Hence, presenting these stimuli doesn't generate much useful data. The staircase method is a more efficient version of the method of constant stimuli. It can be used to eliminate repeated presentations of stimuli well below or above the threshold and to focus instead on presenting stimuli near the threshold.

4. If the volume on an audio device is increased from one to two, how should the physical intensity of the sound be changed so that the perceived intensity is doubled? Explain with the help of Fechner's law.

Ans: According to the text, when the physical intensity of a stimulus is low, doubling the physical stimulus will double the perceived intensity of the stimulus. However, if the intensity of the stimulus is much greater, there should be a considerable increase in the physical stimulus to produce a noticeable difference in the perceived intensity.

5. What is the role of voltage-gated channels in the course of an action potential? Describe the events in which they play their crucial role.

Ans: When a neuron receives a signal from another neuron, the receiving neuron undergoes an abrupt change in membrane potential, which causes voltage-gated sodium channels to open at the base of the axon, where it emerges from the cell body. This in turn allows extracellular sodium ions (Na^+) to flow into the axon. They move into the axon because the concentration of Na^+ ions is much greater outside the membrane than inside. The influx of positively charged Na^+ ions causes the membrane potential to become more positive. This change in membrane potential is called depolarization because the membrane potential is becoming less polarized—that is, less extreme, moving from −70 mV toward 0. If the depolarization surpasses a threshold at about −45 mV, the inflow of Na^+ ions continues rapidly until the difference in electric charge at the inner and outer surfaces of the membrane is reversed, with the inside of the axon becoming more positively charged than the outside, resulting in a membrane potential of about +30 mV at its peak. Immediately after the sodium channels open, they close again, stemming the inflow of Na^+ ions, and nearby potassium channels open (in response to the depolarization of the membrane), allowing positively charged potassium ions (K^+) to flow out of the axon, again driven by the concentration difference. The outflow of K^+ ions pushes the membrane potential back toward its resting value of −70 mV, a process called repolarization. Like the sodium channels, the

potassium channels close again immediately after opening. The membrane potential briefly exceeds the resting potential—this is termed hyperpolarization—before returning to the resting potential.

6. How are neural signals transmitted across a synapse? How do the presynaptic membrane, the postsynaptic membrane, the synaptic vesicles, and neurotransmitters react to an action potential?

Ans: A synapse is a tiny gap between the axon terminal of one neuron and the dendrite or cell body of another neuron. Within an axon terminal, synaptic vesicles contain neurotransmitter molecules. The arrival of an action potential causes the synaptic vesicles to merge with the presynaptic membrane, which releases neurotransmitter molecules into the synapse. Some neurotransmitter molecules drift across the synapse and bind to receptors on the postsynaptic membrane (the neurotransmitter molecules fit into the receptors the way a key fits into a lock). Binding causes ion channels to open on the postsynaptic membrane.

7. What is diffuse optical tomography (DOT), and how is it advantageous over PET and fMRI?

Ans: Diffuse optical tomography (DOT), an emerging type of brain imaging, senses changes in the blood oxygen level in the brain by using optical techniques. DOT employs an array of near-infrared light sources and sensors placed on the head that measure changes in the light reflected by the brain, caused by changes in blood flow. The method has some advantages over PET and fMRI: it does not require the introduction of radioactive substances into the participant's body (as PET does), and it can be used with participants who have metal implanted in their body (fMRI cannot be used with such participants because of the strong magnetic fields produced by that method). Also, DOT can be used in more naturalistic settings than PET and fMRI can be used in because DOT equipment is relatively compact. DOT has similar temporal resolution to fMRI but somewhat lower spatial resolution.

8. Explain how functional neuroimaging can be used to investigate areas in the brain that perform specific functions.

Ans: Functional neuroimaging is an array of techniques that makes it possible for neuroscientists to measure brain activity in healthy volunteers carrying out carefully designed perceptual and cognitive tasks. Functional neuroimaging techniques can be divided into two broad types: techniques for measuring the electrical or magnetic fields produced by populations of active neurons (electroencephalography and magnetoencephalography) and techniques for measuring the changes in blood flow and blood oxygenation that accompany brain activity (positron

emission tomography, functional magnetic resonance imaging, and diffuse optical tomography). All of these techniques rely on the same assumptions of modularity and cognitive uniformity. Electroencephalography (EEG) is a functional neuroimaging technique based on measurement of the electrical fields associated with brain activity.
Magnetoencephalography (MEG) is a functional neuroimaging technique based on measurement of the magnetic fields associated with brain activity. Positron emission tomography (PET) is a functional neuroimaging technique based on measurement of the changes in blood flow associated with brain activity; it relies on the introduction of a radioactive substance into the blood. Functional magnetic resonance imaging (fMRI) is a functional neuroimaging technique based on measurement of the changes in blood oxygenation associated with brain activity; it relies on production of magnetic fields in the brain.

9. Explain the concept of modularity in cognitive neuropsychology with the help of an example.

Ans: Cognitive neuropsychology depends on the concept of modularity. Modularity is the idea that the human mind and brain consist of a set of distinct modules, each of which carries out one or more specific functions. Any complex task involves the coordinated activity of many modules, each contributing its part—for example, the task of typing to spoken dictation engages modules involved in audition, language, and finger movements, among others. A module processes only specific types of information, such as information about faces or about speech—that is, a module is domain specific.

10. Compare the advantages and disadvantages of self-driving cars over human-controlled ones.

Ans: Self-driving cars may be involved in fewer serious accidents and help with gains in human productivity by allowing people to work while traveling. Self-driving cars may be disadvantaged in situations where humans do not strictly abide by driving laws. Many accidents result from driver inattention or from a driver's failure to correctly perceive the speed and location of an approaching vehicle or a road obstruction, and, in theory, the sensors in self-driving cars would never experience such attentional lapses or perceptual failures. However, a recent study has found that the likelihood of a minor accident involving a self-driving car may be greater than with a human-controlled one.