Perception and sensation

Health & Medicine, Body

Inpsychologywe tend to study sensation due to our ways of organizing and responding to the world depend a great deal on the way which our senses filter or select from the stimuli, or information, around us. We come to know our world primarily through our senses, and often what we sense often affect our behaviour. Definition of sensation: Any fundamental experience of events from within or without the body that results from simulation of some receptor system. Sensation is distinguished from perception in that perception requires the interpretation of a sensation.

This distinction is somewhat arbitrary(absolute), however, because some perception of a sensation must occur before awareness of that sensation is possible. To put it in a simpler explanation: Although intimately related, sensation and perception play two complementary but different roles in how we interpret our world. Sensation refers to the process of sensing ourenvironmentthrough touch, taste, sight, sound, and smell. This information is sent to our brains in raw form where perception comes into play. Perception is the way we interpret these sensations and therefore make sense of everything around us.

Simple example of sensation and perception are: Sensation: Physical response. Information which is gathered through one of the human five senses, like touching a guitar string and the feeling of the string structure. Perception: Our mental response towards the sensation, like seeing an electric guitar and thinking of rock and roll. So how do sensation and perception work together? When sensation occurs, the sensory organs absorbs energy from a physical stimulus in the environment and then the sensory receptors convert this energy into neural impulses and send them to the brain.

And then perception follows via the brain process of organizing the information and translate it into something “ meaningful”. The term “ meaningful” in the above context is how the brain determine whether the information is important and whether it should be focused on. We can determine this by using a process called Psychophysics. Psychophysics can be defined as, the study of how physical stimuli are translated into psychological experience. In psychophysics there are two process that can be done to measure the importance of the information that have been gather, Selective Attention and Perceptual Expectancy.

Selective Attention is a process of discriminating between what is important and is irrelevant and is influenced bymotivation. For example, students in a lecture class should be focusing on what the lecturer is saying and the overheads that are being presented. When a student who doesn't take the lecture walk by the classroom, the student may be focusing on the people in the room, who is theteacher, etc and not the same thing the student in the class. Perceptual Expectancy is how we perceive the world is a function of our past experience, cultureand our biological makeup.

For instances, as a local Malaysian city dweller, when I look at a highway I expect to see cars, trucks, etc, NOT airplanes. But for someone from the rural area, aboriginal folks perhaps, who have different experiences and history, they might not have any idea what to expect and thus be surprise when they see cars go driving by. A simpler explanation for perceptual expectancy can be describe with the situation when we look at a picture or painting perhaps, we might not have any idea what the message that they are trying to convey.

But if someone tells you about it, you might be begin to see things in the picture or painting that you were unable to see before. Here is an experiment to test perceptual expectancy. From the picture given above, can you find the hidden tiger? Anyway, in order to measure these psychophysics events psychologist use threshold. A threshold is a dividing line between what has detectable energy and what does not. For example, no matter how bright X-ray light is, you annot see it or although there are some delicate instruments that mighth be able to sense the light from a match struck on a mountaintop 50 miles away on a dark night, your eyes would not be able to. The amount of energy required to create a noticeable sensation is called absolute threshold. A certain amount of energy is required before you can detect a stimulus hence, the existing energy must fluctuate a certain amount before you can detect a certain change in the a stimulus. This minimum amount of energy fluctuation is known as difference threshold. It can also called the Just Noticeable Difference (JND).

Difference threshold also can change depending on the person’s physical condition or motivation or on the qualities of the stimulus being tested. For example, when you pick up a 5kg weight and then a 10kg weight, you can feel a big difference between those two. However if you pick up a 50kg and then 55kg, it is much more difficult to feel the difference. Weber’s Law stated that the larger or the stronger the stimulus, the larger or the change required for an observer to notice a difference. The smallest difference in intensity between two stimuli that can be readily detected is a constant fraction of the original stimulus.

Last but not least there is the Signal Detection Theory where the detection of a stimulus involves some decision making process as well as sensory process. Additionally both sensory and decision making process are influenced by many more factors than just intensify. * Noise:- The factors of how much outside interference that exist that might influence the sensory and decision making process. * Criterion:- The level of assurance that you decide must be met before you take action. It involves higher mental processes. You set the criterion based on expectation and consequences of inaccuracy.

Most people consider that there are five ways to sense, seeing, hearing, tasting, smelling and touching. In reality, there are any more than just these five but ultimately these five are consider the main or standard senses. VISION. Researchers have studied vision more thoroughly than the other senses. Because people need sight to perform most daily activities, the sense of sight has evolved to be highly sophisticated. Vision, however, would not exist without the presence of light. Light is electromagnetic radiation that travels in the form of waves.

Light is emitted from the sun, stars, fire, and light bulbs. Most other objects just reflect light. The usual vision system works on sensing and perceiving light waves. Light waves vary in their length and amplitude: * wave length (also referred to as frequency, since the longer a wave, the less often/quickly it occurs) - affects color perception (ex. , red= approx 700, yellow approx 600) * wave amplitude (this is the size/height of the wave) - affects brightness perception. People experience light as having three features: color, brightness, and saturation.

These three types of experiences come from three corresponding characteristics of light waves: * The color or hue of light depends on its wavelength, the distance between the peaks of its waves. * The brightness of light is related to intensity or the amount of light an object emits or reflects. Brightness depends on light wave amplitude, the height of light waves. Brightness is also somewhat influenced by wavelength. Yellow light tends to look brighter than reds or blues. * Saturation or colorfulness depends on light complexity, the range of wavelengths in light. The color of a single wavelength is pure spectral color.

Such lights are called fully saturated. Outside a laboratory, light is rarely pure or of a single wavelength. Light is usually a mixture of several different wavelengths. The greater number of spectral colors in a light, the lower the saturation. Light of mixed wavelengths looks duller or paler than pure light. Wavelength ——; Color| Amplitude ——; Brightness| Complexity ——; SaturationRainbows and LightsWhite light: Completely unsaturated. It is a mixture of all wavelengths of light. The visible spectrum: Includes the colors of the rainbow, which are red, orange, yellow, green, blue, indigo, and violet.

Ultraviolet light: The kind of light that causes sunburns. It has a wavelength somewhat shorter than the violet light at the end of the visible spectrum. Infrared radiation: Has a wavelength somewhat longer than the red light at the other end of the visible spectrum. STRUCTURE OF THE EYEThe process of vision cannot be understood without some knowledge about the structure of the eye: * The sclera is the white, elastic outer covering of the eye. * The cornea is the transparent outer bulge in front of the eye through which light waves pass * The iris is the pigmented muscular membrane that control the aperture in the center of the pupil.

The iris determines the amount of light that enters the eye. * The iris surrounds an opening called the pupil, the dark circular aperture in the center of the iris of the eye that admits light. The pupil can get bigger or smaller to allow different amounts of light through the lens to the back of the eye. In bright light, the pupil contracts to restrict light intake; in dim light, the pupil expands to increase light intake. * The lens is the transparent biconvex structure of the eye behind the iris and pupil that focuses light rays entering through the pupil to form an image on the retina.

The lens can adjust its shape to focus light from objects that are near or far away. This process is called accommodation. * Light passing through the cornea, pupil, and lens falls onto the retina at the back of the eye. The retina is the delicate multilayer light sensitive membrane lining the inner eyeball It consists of layers of ganglion cells, bipolar cells and photoreceptor cells called rods and cones. The image that falls on the retina is always upside down. * The ganglion cells are the nerve cells of the retina, which receive impulses from rods and cones via the bipolar cells and transmit those impulses to the brain. Optic nerve are the bundle of nerve fibers connecting the retina and the brain. * Bipolar cells are the cells that collect and consolidate visual information. A particular bipolar cell is either rod driven or cone driven, meaning that the cell receives information from either groups of rods or groups of cones but never from a minute of the two. Bipolar cells transmit to the ganglion cells a ratio derived from the signals they receive from the photoreceptors and nearby horizontal cells. * Horizontal cells are the retina cells with short dendrites and long axons that extend horizontally, linking rods and cones with other cones.

Each of these cells fires according to the average light intensity generated by the photoreceptors in its immediate neighbourhood. Horizontal cells are thought to influence the opposing color color processes(such as red and green, blue and yellow) are probably responsible, in part for negative afterimages and other opponent-process effects. * Amacrine cells are the large retinal neurons that connect ganglion cells laterally. There are at least 30 different varieties of amacrine cells. Image reflection appears to be one of their many functions. The functions of most amacrine cells are unknown. The center of the retina, the fovea, is where vision is sharpest. This explains why people look directly at an object they want to inspect. This causes the image to fall onto the fovea, where vision is clearest. EYE TROUBLENearsightedness is the inability to clearly see distant objects. Farsightedness is the inability to clearly see close objects. A cataract is a lens that has become opaque, resulting in impaired vision. Blind spot is the region of the retina where the optic nerve attaches and where there are no photoreceptors. The fovea is also a blind spot when something is viewed in very dim light.

Rods and ConesThe retina has millions of photoreceptors called rods and cones. Photoreceptors are specialized cells that respond to light stimuli. There are many more rods than cones. The long, narrow cells, called rods, are highly sensitive to light and allow vision even in dim conditions. There are no rods in the fovea, which is why vision becomes hazy in dim light. However, the area just outside the fovea contains many rods, and these allow peripheral vision. Because rods are so sensitive to light, in dim lighting conditions peripheral vision is sharper than direct vision.

Example: People can often see a star in the night sky if they look a little to the side of the star instead of directly at it. Looking to the side utilizes peripheral vision and makes the image of the star fall onto the periphery of the retina, which contains most of the rods. Cones are cone-shaped cells that can distinguish between different wavelengths of light, allowing people to see in color. Cones don't work well in dim light, however, which is why people have trouble distinguishing colors at night. The fovea has only cones, but as the distance from the fovea increases, the umber of cones decreases. | Feature| Rods| Cones| Shape| Long and narrow| Cone-shaped| Sensitivity to light| High: help people to see in dim light| Low: help people to see in bright light| Help color vision| No| Yes| Present in fovea| No| Yes| Abundant in periphery of retina| Yes| No| Allow peripheral vision| Yes| No| ADAPTATION TO LIGHT Dark adaptation is the process by which receptor cells sensitize to light, allowing clearer vision in dim light. Light adaptation is the process by which receptor cells desensitize to light, allowing clearer vision in bright light. Connection to the Optic Nerve

Rods and cones connect via synapses to bipolar neurons, which then connect to other neurons called ganglion cells. The axons of all the ganglion cells in the retina come together to make up the optic nerve. The optic nerve connects to the eye at a spot in the retina called the optic disk. The optic disk is also called the blind spot because it has no rods or cones. Any image that falls on the blind spot disappears from view. Transmission of Visual Information Visual information travels from the eye to the brain as follows: *

Light reflected from an object hits the retina’s rods and cones. Rods and cones send neural signals to the bipolar cells. * Bipolar cells send signals to the ganglion cells. * Ganglion cells send signals through the optic nerve to the brain. Bipolar and ganglion cells gather and compress information from a large number of rods and cones. The rods and cones that send information to a particular bipolar or ganglion cell make up that cell’s receptive field. Ganglion cell axons from the inner half of each eye cross over to the opposite half of the brain. This means that each half of the brain receives signals from both eyes.

Signals from the eyes’ left sides go to the left side of the brain, and signals from the eyes’ right sides go to the right side of the brain. The diagram below illustrates this process. Visual Processing in the Brain After being processed in the thalamus and different areas of the brain, visual signals eventually reach the primary visual cortex in the occipital lobe of the brain’s cerebrum. In the 1960s, David Hubel and Torsten Wiesel demonstrated that highly specialized cells called feature detectors respond to these visual signals in the primary visual cortex.

Feature detectors are neurons that respond to specific features of the environment, such as lines and edges. From the visual cortex, visual signals often travel on to other parts of the brain, where more processing occurs. Cells deeper down the visual processing pathway are even more specialized than those in the visual cortex. Psychologists theorize that perception occurs when a large number of neurons in different parts of the brain activate. These neurons may respond to various features of the perceived object such as edges, angles, shapes, movement, brightness, and texture.

Color Vision Objects in the world seem to be brightly colored, but they actually have no color at all. Red cars, green leaves, and blue sweaters certainly exist—but their color is a psychological experience. Objects only produce or reflect light of different wavelengths and amplitudes. Our eyes and brains then convert this light information to experiences of color. Color vision happens because of two different processes, which occur in sequence: * The first process occurs in the retina and is explained by the trichromatic theory. The second process occurs in retinal ganglion cells and in cells in the thalamus and visual cortex. The opponent process theory explains this process. These two theories are explained below. The Trichromatic Theory Thomas Young and Hermann von Helmholtz proposed the trichromatic theory, or Young-Helmholtz theory. This theory states that the retina contains three types of cones, which respond to light of three different wavelengths, corresponding to red, green, or blue. Activation of these cones in different combinations and to different degrees results in the perception of other colors. Color Mixing

Mixing lights of different colors is called additive color mixing. This process adds wavelengths together and results in more light. Mixing paints, on the other hand, is called subtractive color mixing, a process that removes wavelengths so that there is less light. If red, orange, yellow, green, blue, indigo, and violet light were mixed, the result would be white light. If the same color paints were mixed together, the result would be a dark, muddy color. The trichromatic theory also accounts for color blindness, a hereditary condition that affects a person’s ability to distinguish between colors.

Most color-blind people are dichromats, which means they are sensitive to only two of the three wavelengths of light. Dichromats are usually insensitive either to red or green, but sometimes they cannot see blue. The Opponent Process Theory Ewald Hering proposed the opponent process theory. According to this theory, the visual system has receptors that react in opposite ways to three pairs of colors. The three pairs of colors are red versus green, blue versus yellow, and black versus white. Some receptors are activated by wavelengths corresponding to red light and are turned off by wavelengths corresponding to green light.

Other receptors are activated by yellow light and turned off by blue light. Still others respond oppositely to black and white. Opponent process theory explains why most people perceive four primary colors: red, green, blue, and yellow. If trichromatic theory alone fully explained color vision, people would perceive only three primary colors, and all other colors would be combinations of these three colors. However, most people think of yellow as primary rather than as a mixture of colors. Opponent process theory also accounts for complementary or negative afterimages.

Afterimages are colors perceived after other, complementary colors are removed. Example: If Jack stares at a picture of a red square, wavelengths corresponding to red will activate the matching receptors in his visual system. For the sake of simplicity, these matching receptors can be referred to as red receptors. Anything that makes red receptors increase firing will be seen as red, so Jack will see the square as red. Anything that decreases the firing of red receptors will be seen as green. If Jack stares at the square for a while, the red receptors will get tired out and start to fire less.

Then if he looks at a blank white sheet of paper, he will see a green square. The decreased firing of the red receptors produces an experience of a green afterimage. Form Perception The ability to see separate objects or forms is essential to daily functioning. Suppose a girl sees a couple in the distance with their arms around each other. If she perceived them as a four-legged, two-armed, two-headed person, she'd probably be quite disturbed. People can make sense of the world because the visual system makes sensible interpretations of the information the eyes pick up.

Gestalt psychology, a school of thought that arose in Germany in the early twentieth century, explored how people organize visual information into patterns and forms. Gestalt psychologists noted that the perceived whole is sometimes more than the sum of its parts. An example of this is the phi phenomenon, or stroboscopic movement, which is an illusion of movement that happens when a series of images is presented very quickly, one after another. Example: The phi phenomenon is what gives figures and objects in movies the illusion of movement.

In reality, a movie is a series of still images presented in rapid succession. Gestalt Principles Gestalt psychologists described several principles people use to make sense of what they see. These principles include figure and ground, proximity, closure, similarity, continuity, and simplicity: * Figure and ground: One of the main ways people organize visual information is to divide what they see into figure and ground. Figure is what stands out, and ground is the background in which the figure stands. People may see an object as figure if it appears larger or brighter relative to the background.

They may also see an object as figure if it differs noticeably from the background or if it moves against a static environment. * Proximity: When objects lie close together, people tend to perceive the objects as a group. For example, in the graphic below, people would probably see these six figures as two groups of three. * Closure: People tend to interpret familiar, incomplete forms as complete by filling in gaps. People can easily recognize the following figure as the letter k in spite of the gaps. * Similarity: People tend to group similar objects together.

In the next figure, people could probably distinguish the letter T because similar dots are seen as a group. * Continuity: When people see interrupted lines and patterns, they tend to perceive them as being continuous by filling in gaps. The next figure is seen as a circle superimposed on a continuous line rather than two lines connected to a circle. * Simplicity: People tend to perceive forms as simple, symmetrical figures rather than as irregular ones. This figure is generally seen as one triangle superimposed on another rather than a triangle with an angular piece attached to it. Depth Perception

To figure out the location of an object, people must be able to estimate their distance from that object. Two types of cues help them to do this: binocular cues and monocular cues. Binocular Cues Binocular cues are cues that require both eyes. These types of cues help people to estimate the distance of nearby objects. There are two kinds of binocular cues: retinal disparity and convergence. * Retinal disparity marks the difference between two images. Because the eyes lie a couple of inches apart, their retinas pick up slightly different images of objects. Retinal disparity increases as the eyes get closer to an object.

The brain uses retinal disparity to estimate the distance between the viewer and the object being viewed. * Convergence is when the eyes turn inward to look at an object close up. The closer the object, the more the eye muscles tense to turn the eyes inward. Information sent from the eye muscles to the brain helps to determine the distance to the object. Monocular Cues Monocular cues are cues that require only one eye. Several different types of monocular cues help us to estimate the distance of objects: interposition, motion parallax, relative size and clarity, texture gradient, linear perspective, and light and shadow. Interposition: When one object is blocking part of another object, the viewer sees the blocked object as being farther away. * Motion parallax or relative motion: When the viewer is moving, stationary objects appear to move in different directions and at different speeds depending on their location. Relatively close objects appear to move backward. The closer the object, the faster it appears to move. Distant objects appear to move forward. The further away the object, the slower it appears to move. * Relative size: People see objects that make a smaller image on the retina as farther away. Relative clarity: Objects that appear sharp, clear, and detailed are seen as closer than more hazy objects. * Texture gradient: Smaller objects that are more thickly clustered appear farther away than objects that are spread out in space. * Linear perspective: Parallel lines that converge appear far away. The more the lines converge, the greater the perceived distance. * Light and shadow: Patterns of light and shadow make objects appear three-dimensional, even though images of objects on the retina are two-dimensional. Creating Perspective

Artists use monocular cues to give a three-dimensional appearance to two-dimensional pictures. For instance, if an artist wanted to paint a landscape scene with a straight highway on it, she would show the edges of the highway as two parallel lines gradually coming together to indicate that the highway continues into the distance. If she wanted to paint cars on the highway, she would paint bigger cars if she wanted them to seem closer and smaller cars if she wanted them to seem farther away. Perceptual Constancy Another important ability that helps people make sense of the world is perceptual constancy.

Perceptual constancy is the ability to recognize that an object remains the same even when it produces different images on the retina. Example: When a man watches his wife walk away from him, her image on his retina gets smaller and smaller, but he doesn’t assume she’s shrinking. When a woman holds a book in front of her face, its image is a rectangle. However, when she puts it down on the table, its image is a trapezoid. Yet she knows it’s the same book. Although perceptual constancy relates to other senses as well, visual constancy is the most studied phenomenon.

Different kinds of visual constancies relate to shape, color, size, brightness, and location. * Shape constancy: Objects appear to have the same shape even though they make differently shaped retinal images, depending on the viewing angle. * Size constancy: Objects appear to be the same size even though their images get larger or smaller as their distance decreases or increases. Size constancy depends to some extent on familiarity with the object. For example, it is common knowledge that people don’t shrink. Size constancy also depends on perceived distance.

Perceived size and perceived distance are strongly related, and each influences the other. * Brightness constancy: People see objects as having the same brightness even when they reflect different amounts of light as lighting conditions change. * Color constancy: Different wavelengths of light are reflected from objects under different lighting conditions. Outdoors, objects reflect more light in the blue range of wavelengths, and indoors, objects reflect more light in the yellow range of wavelengths. Despite this, people see objects as having the same color whether they are outdoors or indoors because of two factors.

One factor is that the eyes adapt quickly to different lighting conditions. The other is that the brain interprets the color of an object relative to the colors of nearby objects. In effect, the brain cancels out the extra blueness outdoors and the extra yellowness indoors. * Location constancy: Stationary objects don’t appear to move even though their images on the retina shift as the viewer moves around. Visual Illusions The brain uses Gestalt principles, depth perception cues, and perceptual constancies to make hypotheses about the world. However, the brain sometimes misinterprets information from the senses and makes incorrect hypotheses.

The result is an optical illusion. An illusion is a misinterpretation of a sensory stimulus. Illusions can occur in other senses, but most research has been done on visual illusions. In the famous Muller-Lyer illusion shown here, the vertical line on the right looks longer than the line on the left, even though the two lines are actually the same length. This illusion is probably due to misinterpretation of depth perception cues. Because of the attached diagonal lines, the vertical line on the left looks like the near edge of a building, and the vertical line on the right looks like the far edge of a room.

The brain uses distance cues to estimate size. The retinal images of both lines are the same size, but since one appears nearer, the brain assumes that it must be smaller. Perceptual Set The Muller-Lyer illusion doesn't fool everyone equally. Researchers have found that people who live in cities experience a stronger illusion than people who live in forests. In other words, city-dwelling people see the lines as more different in size. This could be because buildings and rooms surround city dwellers, which prepares them to see the lines as inside and outside edges of buildings.

The difference in the strength of the illusion could also be due to variations in the amount of experience people have with making three-dimensional interpretations of two-dimensional drawings. Cultural differences in the tendency to see illusions illustrate the importance of perceptual set. Perceptual set is the readiness to see objects in a particular way based on expectations, experiences, emotions, and assumptions. Perceptual set influences our everyday perceptions and how we perceive reversible figures, which are ambiguous drawings that can be interpreted in more than one way.

For example, people might see a vase or two faces in this famous figure, depending on what they're led to expect. Selective Attention Reversible figures also illustrate the concept of selective attention, the ability to focus on some bits of sensory information and ignore others. When people focus on the white part of the figure, they see a vase, and when they focus on the black part of it, they see two faces. To use the language of Gestalt psychology, people can choose to make the vase figure and the face ground or vice versa.

Selective attention allows people to carry on day-to-day activities without being overwhelmed by sensory information. Reading a book would be impossible if the reader paid attention to not only the words on the page but also all the things in his peripheral vision, all the sounds around him, all the smells in the air, all the information his brain gets about his body position, air pressure, temperature, and so on. He wouldn't get very far with the book. Context Effects Another factor that influences perception is the context of the perceiver. People's immediate surroundings create expectations that make them see in particular ways.

Example: The figure below can be seen either as a sequence of letters, A B C, or a sequence of numbers, 12 13 14, depending on whether it is scanned across or down. HEARING Hearing, or audition, depends on the presence of sound waves, which travel much more slowly than light waves. Sound waves are changes in pressure generated by vibrating molecules. The physical characteristics of sound waves influence the three psychological features of sound: loudness, pitch, and timbre. * Loudness depends on the amplitude, or height, of sound waves. The greater the amplitude, the louder the sound perceived. Amplitude is measured in decibels.

The absolute threshold of human hearing is defined as 0 decibels. Loudness doubles with every 10-decibel increase in amplitude. A Whisper to a Scream The loudness of normal human conversation is about sixty decibels. A whisper is about twenty decibels. A shout right into someone's ear is about 115 decibels. Being exposed to sounds that are over 120 decibels, even for brief periods, can damage the auditory system. * Pitch, though influenced by amplitude, depends most on the frequency of sound waves. Frequency is the number of times per second a sound wave cycles from the highest to the lowest point.

The higher the frequency, the higher the pitch. Frequency is measured in hertz, or cycles per second. Frequency also affects loudness, with higher-pitched sounds being perceived as louder. Amplitude and frequency of sound waves interact to produce the experiences of loudness and pitch. What's Audible? Humans can hear sounds that are between 20 and 20, 000 hertz. * Timbre, or the particular quality of a sound, depends on thecomplexity of a sound wave. A pure tone has sound waves of only one frequency. Most sound waves are a mixture of different frequencies. The Structure of the Ear

Knowing the basic structure of the ear is essential to understanding how hearing works. The ear has three basic parts: the outer ear, the middle ear, and the inner ear. The visible part of the ear is the pinna, which collects sound waves and passes them along the auditory canal to a membrane called the eardrum. When sound waves hit the eardrum, it vibrates. The eardrum transmits the vibration to three bones, or ossicles, in the middle ear, which are called the hammer, the anvil, and the stirrup. The diagram of the ear shows how they got these names: they actually look like a hammer, an anvil, and a stirrup.

In response to the vibration, these ossicles move one after another. Their function is to amplify the sound vibrations. From the ossicles, vibrations move through a membrane called the oval window to the cochlea of the inner ear. The cochlea is a coiled, fluid-filled tunnel. Inside the cochlea are receptors called cilia or hair cells that are embedded in the basilar membrane. The basilar membrane runs along the whole length of the coiled cochlea. Vibrations that reach the inner ear cause the fluid in the cochlea to move in waves. These waves in turn make the hair cells move.

The movement triggers impulses in neurons that connect with the hair cells. The axons of these neurons come together to form the auditory nerve, which sends impulses from the ear to the brain. In the brain, the thalamus and the auditory cortex, which is in the temporal lobe of the cerebrum, receive auditory information. Pitch Perception Two theories explain how people distinguish the pitch of different sounds: place theory and frequency theory. Place theory explains how people discriminate high-pitched sounds that have a frequency greater than 5000 Hz.

Place theory states that sound waves of different frequencies trigger receptors at different places on the basilar membrane. The brain figures out the pitch of the sound by detecting the position of the hair cells that sent the neural signal. Frequency theory explains how people discriminate low-pitched sounds that have a frequency below 1000 Hz. According to frequency theory, sound waves of different frequencies make the whole basilar membrane vibrate at different rates and therefore cause neural impulses to be sent at different rates.

Pitch is determined by how fast neural signals move along to the brain. The detection of moderately pitched sounds, with a frequency between 1000 and 5000 Hz, is explained by both place theory and frequency theory. To discriminate among these sounds, the brain uses a code based both on where the neural impulses originated and how quickly neural impulses move.

Locating Sounds In the same way that people use two eyes to perceive depth, people use two ears to locate the origin of sounds. The left ear receives sound waves coming from the left slightly faster than the right ear does.

The signal received by the left ear may also be a little more intense than that received in the right ear, because the signal has to go around the head to enter the right ear. Locating a sound is difficult if both ears receive a signal of exactly the same intensity at exactly the same time, as when a sound originates from directly in front, directly behind, or directly above. Turning the head or cocking it to one side can help circumvent this difficulty. TASTE AND SMELL. Taste and smell are chemical senses. As light waves stimulate vision and sound waves stimulate sound, chemicals stimulate taste and smell. TASTE

Taste, or gustation, happens when chemicals stimulate receptors in the tongue and throat, on the inside of the cheeks, and on the roof of the mouth. These receptors are inside taste buds, which in turn are inside little bumps on the skin called papillae. Taste receptors have a short life p and are replaced about every ten days. For a long time, researchers believed in the existence of four tastes: salty, sweet, sour, and bitter. Recently, researchers have suggested the presence of a fifth taste called umami. The spice monosodium glutamate (MSG) has an umami taste, as do many protein-rich foods. Taste is also strongly influenced by smell.

SMELL Smell, or olfaction, happens when chemicals in the air enter the nose during the breathing process. Smell receptors lie in the top of the nasal passage. They send impulses along the olfactory nerve to the olfactory bulb at the base of the brain. Researchers theorize that there are a great many types of olfactory receptors. People perceive particular smells when different combinations of receptors are stimulated. Remembrance of Smells Past The sense of smell is closely connected with memory. Most people have had the experience of smelling something, maybe a certain perfume or spice, and suddenly experiencing a strong emotional memory.

Researchers don't know exactly why this happens, but they theorize that smell and memory trigger each other because they are processed in neighboring regions of the brain. POSITION MOVEMENT AND BALANCE Kinesthesis is the sense of the position and movement of body parts. Through kinesthesis, people know where all the parts of their bodies are and how they are moving. Receptors for kinesthesis are located in the muscles, joints, and tendons. The sense of balance or equilibrium provides information about where the body exists in space.

The sense of balance tells people whether they are standing up, falling in an elevator, or riding a roller coaster. The sensory system involved in balance is called the vestibular system. The main structures in the vestibular system are three fluid-filled tubes calledsemicircular canals, which are located in the inner ear. As the head moves, the fluid in the semicircular canals moves too, stimulating receptors called hair cells, which then send impulses to the brain. TOUCH he sense of touch is really a collection of several senses, encompassing pressure, pain, cold, and warmth.

The senses of itch and tickle are related to pressure, and burn injuries are related to pain. Touch receptors are stimulated by mechanical, chemical, and thermal energy. Pressure seems to be the only kind of touch sense that has specific receptors. The Gate-Control Theory of Pain Researchers don’t completely understand the mechanics of pain, although they do know that processes in the injured part of the body and processes in the brain both play a role. In the 1960s, Ronald Melzack and Patrick Wall proposed an important theory about pain called the gate-control theory of pain.

Gate-control theorystates that pain signals traveling from the body to the brain must go through a gate in the spinal cord. If the gate is closed, pain signals can’t reach the brain. The gate isn’t a physical structure like a fence gate, but rather a pattern of neural activity that either stops pain signals or allows them to pass. Signals from the brain can open or shut the gate. For example, focusing on pain tends to increase it, whereas ignoring the pain tends to decrease it. Other signals from the skin senses can also close the gate. This process explains why massage, ice, and heat relieve pain.