SENSATION AND PERCEPTION

Overview

Today's lecture is about how we use information from the outside world and transform it. The sensation process is about how our sense organs respond to external stimuli and how the information they get is transmitted to the brain. Perception is about how changes in the brain give rise to the experience of reality we have. When we perceive, we try to interpret the information to figure out what is that thing and what can I do with it. What's happening in the world is not the same as what we experience, understanding happens in the mind.

We have five senses: vision, hearing, touch, smell, and taste. Touch and taste are proximal senses, meaning in order to detect the information you have to be in contact with it. Vision, smelling and hearing are distal senses; we can see and hear information that is not in direct contact with us. Today we are focusing on vision, not because the other senses are not important. It's because vision is the most important and most complex sense. Vision is the sense with the most brain area devoted to it.

Steps in the sensation and perception of a tree

The real tree is a distal stimulus. Light bounces from the tree, enters our eye and hits the retina, where the tree is projected as a flat image upside down. Then receptive cells called rods and cones which are activated by light transform the information into an electrical signal that can be understood by brain. The signal travels from the eye, to the optic nerve, to occipital lobe. The occipital lobe converts the electrical information and looks for shapes, shading, and other basic information. The information is then processed by different parts of the lobe then, integrated. These are low level experiences. Those sensations are integrated by other perceptual parts, so that we understand it and figure out what is it, where is it, using the temporal and parietal lobes. Then we experience the object as a tree. Different parts of the brain work together on this task.

The same process happens with sound. Receptors transform input from the environment into electrical information, which is then transmitted to brain. The input is integrated, and we have the experience of what we are hearing.

Video clip of neuron activity: In the video clip, we learn about the activity of a single neuron in the brain when a rat is exposed to changes in a visual stimulus. The activity is measured with an electrode. Each neuron has a particular role in vision and responds to a particular stimulus. We see that when the line of light moves, the neuron stops responding, when the orientation changes, the neuron stops firing. Also the neuron only fires when the line is within specific boundaries. This video shows how specific neurons can be.

Color vision

Rods and cones play different role in the retina for using light information. We have about 120 millions rods in the retina of each eye, and only about 6 millions cones. Rods are useful in low light vision. They are bad for perceiving details and colors. Cones are for situations in which there is a lot of light. They are sensitive to color and good with detail.

There are 3 types of cones and they are sensitive to colors: some cones code for red, some for green, and some for blue. The **trichromatic theory of light** is a theory according to which these 3 colors are enough for our color vision. In a way, all colors are just combinations of those.

Class demonstration: we all looked at one side of the screen that had a yellow, green and black flag, then we moved our eyes to the right side of the screen which was blank, and we saw a red white and blue flag. This effect challenges the trichromatic theory. Another theory was proposed to account for this effect: **opponent process theory**. According to this theory, ganglion cells which are also receptors are responsible for this effect. There are 3 basic opposites in color perception: white and black, blue and yellow, red and green. The ganglions active for red suppress green. When the information comes from the rods and cones that an image has green, yellow and black, ganglion cells basically focus on the observed colors and suppress the opposite colors (here red, white blue). When we move our eyes to a blank screen, it is no longer necessary to suppress white, blue and red because we are not looking at green, yellow and black anymore. So red white and blue appear. The trichromatic and the opponent process theories account for different stages of color perception: stage 1: by rods and cones, stage 2: by ganglions.

Main ideas in perception

Perception is about how we make sense of sensory information. It's how we answer "what is all this stuff and how can I understand it?". Figuring out what something is and where it is are handled by different parts of the brain. Perception is sensory experience + our expectations on what we should be seeing, which can affect what we end up seeing. We can use information from the senses (bottom up processing) and our expectations, beliefs, knowledge of the world to understand the information (top down processing).

The what and where pathways are done by different parts of the brain. The primary visual area handles the low level information. The **What** is done by the temporal lobe. The **Where is it in my visual field** is handled by the upper parts of the parietal and occipital lobes. As a result, people with specific brain damages loose one thing and not the other. People with visual agnosia can pick up an object, they know where it is in the visual field but they don't know what it is. They might be able to talk about a vase with red roses, they can for instance say that they see green, red, but they don't have the experience that it's flowers. People with damage to the where pathway may know that it's flowers, but they can't grasp them.

Sensation + theory = perception. "Perception without conception is blind" (Immanuel Kant). Seeing something is not just about picking up parts and turning them into experience, it also involves our beliefs. What we typically experience isn't what's happening in the world, it's how we interpret the world.

We are sensitive to lines and corners. In class, we have experienced **Lateral inhibition**: The shades of grey in the two circles were the same, but we see the one to the left (white background) as darker and the one to the right as lighter. Our perceptual system darkens the one to the left to help us differentiate circle from background, the opposite happens in the black background. We don't doubt our perceptual experience, and yet, it's sometimes wrong. If we were just using the sensory experience, the information about the light projected from the circles, we would have gotten it right that the shades are the same. But our minds use a lot of extra information to make sense of sensory information (surroundings, shading tells us that the object under shade is lighter than we see it). Our perceptual processes are not dependent on our intentions, and not bad. Usually, it's very useful to use all of this extra information to make sense of the world. Often times, we are exposed to information that is ambiguous, incomplete, so we need to have these theories to better navigate the world.

In class we also looked at a photograph we had a hard time identifying. But once we are told that it's a cow, and we see the cow, it's hard not to see it as a cow. The visual system uses that knowledge consistently. Even if the image disappears and we are exposed to it later, we don't hesitate about what it is. The top down knowledge is helping us make sense of the image of the cow.

Our visual system is very flexible and adaptive. Even though we are exposed to a lot of information, our mind is very good at adapting to new challenges in the world. We watched a video which illustrates the adaptiveness of our visual system. The woman in this video was asked to wear special goggles that made her view the world upside down. Imagine pouring milk in a coffee cup, writing your name, when everything is upside down. These tasks were difficult for the woman. After one week, the woman was so used to the upside down world that she had no trouble biking. Her brain had adjusted. When she took the goggles out, it only took her an hour to adjust back. So the brain is plastic, and ready to help us adapt to a world that changes. Note that it only took her an hour to readapt. Our world has so much experience seeing things that way, it is easy.

Some of the information can't be sensed but can be perceived. We all see 3D shapes, but 3D is not sensed. The retina is a flat surface, and when an image is projected on in, it's projected in 2D. Yet, we can perceive 3D. How? The visual system infers it (if it is inferred, then it's note happening in the world as we see it).

Another example: **size and shape constancy.** When we see a picture of gates opening, we see the gates as moving. We don't think that the gates are changing shape. But our retina does not know that opened gates and closed gates are the same. It is perception which tells us about motion, not sensation.

Another example: **depth perception**. We don't have a sensation of depth, we use other cues to estimate depth (depth is an inference). We use our knowledge of linear perspective: two parallel lines are closer when they are far from us, and far apart when they are close to us. That knowledge gives us information on depth, so we draw inferences about the size of things close or far, and our brains make the adjustments from retinal images to perception automatically.

One more example: **height information**. When things are closer to horizon, we understand that it's far. We use that information to make adjustments on how big the object is. **Moon illusion**: when the moon is close to horizon, we think it's bigger, but when the moon is not close to the horizon, we look up, and don't have any reference point, so we think it's small.

Main ideas for today

- Sensation: breaching physical and psychological
- Different parts of the brain are specialized for different tasks (where and what pathways)
- Perception involves making sense of sensation
- Perception is a product of both bottom up sensory processes and top down knowledge