Chapter 9

**VISUAL ATTENTION**

Attention is a set of processes that allow us to select or focus on certain stimuli. Attention can be sustained or temporary. Selective attention allows us to focus on one stimulus when many are present, whereas divided attention occurs when attending to multiple sources of information. Posner and his colleagues investigated whether it is possible to attend to spatial locations other than the location at which one is looking. Posner concluded that one can indeed devote attention covertly, i.e. to a space one is not directly looking at with our foveae. Several characteristics and phenomena of attention are worth noting. Stimulus salience means that some objects in the environment attract our attention, and attentional capture is the process in which a stimulus causes a shift in attention. History of previous reward and relevant semantic meaning both tend to capture attention. Change blindness is the difficulty in detecting differences between two visual stimuli that are identical except for one or more changes to the image. People can even be change blind to the substitution of an actual person. Inattentional blindness is the phenomenon in which a person fails to perceive an object that is visible but not attended to, most famously demonstrated in the invisible gorilla experiment. Visual search, one of the most important tasks in vision, is necessary to find a particular object amid a background of visual distraction. Feature integration theory posits that some visual features can be processed in parallel and quickly prior to using attentional resources, whereas other visual characteristics require us to use attention and are done serially and therefore less quickly. The rapid serial visual presentation (RSVP) paradigm displays a series of stimuli rapidly in time at the same point of visual space. In this paradigm, attentional blink occurs when one response more slowly or not at all to the second target in an RSVP task when the second stimulus occurs within a half second of the first stimulus. Finally, repetition blindness is the failure to detect the second target in an RSVP task when the second target is identical to the first one.

Neurologically, visual attention seems to be primarily controlled by two neural networks. Based on circuits in the parietal lobe, the orienting attention network allows one to engage in visual search and to direct visual attention to different locations in visual space. Based in the superior frontal sulcus/gyrus, the executive attention network allows one to inhibit auditory stimuli so that we can concentrate on the visual world, and vice versa. When a neurological injury affects the right posterior parietal lobe, it may result in unilateral visual neglect, a condition in which one fails to attend to stimuli on the left side of the visual world, though they can still actually see the left visual world. Bálint’s syndrome is a rare condition in which both posterior parietal lobes have been compromised, leading to a limited ability to localize objects in space and difficulty in grasping objects.

Introduction

* Attention is a set of processes that allow us to select or focus on some stimuli.
* Though the focus of this chapter is on visual attention, attention can be directed to auditory or somatosensory sources.
* Attention can be directed externally to perceptual features of the world, but also internally to thought or imaginal processes.
* Attention can be sustained or temporary.
* Attention can be overt or covert.

Selective Attention: Covert Attention

Selective Attention

* **Selective attention** is defined as the processes of attention that allow us to focus on one source when many are present.
* **Divided attention** is defined as the processes of attending to multiple sources of information.

Attention and the Direction of Gaze in Space

* Is it possible to attend to spatial locations other than the location we are looking at?
* Posner and colleagues investigated this possibility in a series of experiments in the 1970s and 1980s.
  + A participant is was directed to look at a central fixation light.
  + The participant then sees an arrow appearing either just to the left or right of the fixation mark
  + The arrow serves as a cue, which directs the participant’s attention in visual space.
  + The task is to maintain focus on the fixation light, but direct covert attention in the direction of the arrow.
  + Then, a light (target) appears either on the same side as the cue or opposite the cue. In most trials, the target appears in the cued location, but in some it does not.
  + Although participants cannot look at the cued area, their response times are faster when the cues are valid.
  + It can be concluded that we can devote attention covertly, i.e., to a space we are not directly looking at.
* Posner also varied **stimulus onset asynchrony**, or the difference in time between the occurrence of one stimulus and the occurrence of another, i.e., the cue and the target.
  + If stimulus onset asynchrony is zero, the cue and target occur simultaneously.
    - When this occurred, there was no difference in reaction time between valid and invalid signals.
  + If the stimulus onset asynchrony is 200ms, the target occurs 200ms after the cue is presented.
    - When this occurred, there were faster reaction times for targets in the valid location than targets in the invalid location.
  + These experiments also showed that the disadvantage for invalid trials was bigger than the advantage for valid trials.
* Posner (1980) compared attention to a spotlight that we can shine on particular locations in space, but this spotlight could be directed at places that we are not actually looking at.
* Egly et al. (1994) showed that areas including an object identical to the object we are attending to will benefit even if we do not directly attend to the area that includes the object.

Features of Attention

Stimulus Salience

* **Stimulus salience** means that some objects in the environment attract our attention.
  + Generally, stimuli that are novel or unexpected will act to divert our attention to them.
* **Attentional capture** is the process by which a stimulus causes a shift in attention.
  + A stimulus that has been previously associated with reward tends to capture our attention.
  + Semantic meaning may also capture attention in a visual scene, especially when the stimulus is processed by the fovea.

Change Blindness

* **Change blindness** is the counterintuitive effect in which we have difficulty in detecting differences between two visual stimuli that are identical except for one or more changes to the image.
* Simons and Levins (1997) classically demonstrated change blindness by asking a person for directions. When the person started giving directions, two experimenters posing as construction workers passed between the experimenter who asked for directions and the participant. At this point, the first experimenter hid behind the door and another person of the same age and sex replaced him. Nearly 50% of the time, the person giving directions did not notice it was a different person.
* Though change blindness occurs, an electroencephalography study (Busch, 2013) suggests that neural changes occur despite no change in behavior.
* A transcranial magnetic stimulation study (Beck et al., 2006) suggests that the right parietal lobe, but not the left, may be critical for this form of attention.

Inattentional Blindness

* **Inattentional blindness** refers to a phenomenon in which people fail to perceive an object or event that is visible but not attended to.
* The most famous demonstration of this phenomena is the invisible gorilla experiment, in which six people are passing a basketball around while weaving among one another. Three people are wearing white shirts and three black shirts. Viewers are instructed to count the number of times the team with white shirts passes the ball among themselves. Shortly into the video, a person wearing a gorilla walks into the scene and then walks off. Nearly half (46%) of participants failed to notice the gorilla.
* In another experiment, most radiologists failed to notice a small image of a gorilla on a CT scan they were asked to inspect for evidence of lung disease.

Visual Search

* **Visual search** is one of the most important tasks in vision, i.e., looking for and finding a particular object amid a background of visual distraction.
* In the laboratory, many aspects of visual search can be controlled, like the size, shape, color, and location of the search item and/or distracting items.
  + In a **feature search**, an item that differs along one dimension must be identified (e.g., color).
  + In a **conjunction search,** an item that differs along two dimensions must be identified (e.g., color and orientation).
  + In a spatial configuration search, a particular shape among several related shapes must be identified.

Feature Integration Theory

* **Feature integration theory** posits that some visual features can be processed in parallel and quickly prior to using attentional resources, whereas other visual characteristics require us to use attention and are done serially and therefore less quickly.

Attentional Blink and Rapid Serial Visual Presentation

* Attention across time rather than space has been studied with the **rapid serial visual presentation (RSVP) paradigm.**
  + A series of stimuli, usually letters or photographs, appear rapidly in time at the same point in visual space.
  + The task is to determine when a particular stimulus appears and to press a button as fast as possible after that stimulus occurs.
  + The RSVP paradigm allows various manipulations that can determine what enhances the attentional focus on the stimulus to be responded to.
* The phenomenon called **attentional blink** refers to the tendency to respond slower or not at all to the second appearance of a target in an RSVP task.
  + Attentional blink seems to occur due to an inhibition mechanisms that dampens responses to other targets while searching for the intended target.
* Another phenomenon called **repetition blindness** refers to the failure to detect the second target in an RSVP task when the second target is identical to the first one.

The Anatomy and Physiology of Attention

The Orienting Attention Network

* The **orienting attention network** is a neural system that allows us to engage in visual search and direct visual attention to different locations in visual space.
* It is based on circuits in the parietal lobe.
* Damage to this network can cause several neurological conditions, such as unilateral neglect.

The Executive Attention Network

* The **executive attention network** is a neural system that allows us to inhibit auditory stimuli so that we can concentrate on visual stimuli, or vice versa.
* It also operates on attention directed at memory and higher order cognitions.
* It is based in the superior frontal sulcus/gyrus region.

How Attention Affects the Visual Brain

* Attention is only useful if it can alter the efficiency of other cognitive processes.
* Neutrally, it must act on other areas of the brain that are otherwise engaged in the visual task at hand.
* Thus, attention must be both a “command” from an attention network and a change in perceptual processing in visual areas of the brain.
* Directing attention affects neural processing in visual areas of the brain.

The Neuropsychology of Attention

* When a stroke or other neurological injury affects the right posterior parietal lobe, a condition called **unilateral visual neglect** may arise, leading to a deficit in the left visual world.
* Those with this condition fail to attend to stimuli on one side of the visual world (usually the left), though they can still see the left visual world.
* That is, unilateral visual neglect is an attention problem, not a visual problem
* When asked to draw a picture of a house, a patient only draws the right side of it.
* A visual imagery deficit may mirror the perceptual deficit, such that when asked to describe a scene from memory only the right side is described.
* Wearing prism glasses is a successful treatment technique because they shift the left visual world into the right visual world.

Bálint’s Syndrome

* **Bálint’s syndrome** is a rare condition in which function in both the left and right posterior parietal lobes has been compromised.
* Patients have a limited ability to localize objects in space, resulting in difficulty grasping objects.
* Also, patients rarely move their eyes, leading to **simultagnosia**, a deficit in perceiving more than one object at a time.

Developmental Aspects of Visual Attention

* Attention in very young infants is determined by how long they can maintain a gaze at a stimulus.
* Infants can maintain the direction of gaze for a considerable time, indicative of attentional control.
* The oddball procedure is one method of studying attention in young infants.
  + An infant is shown several related objects (e.g., different kinds of balls).
  + After a number of balls have been shown to the infant, a novel object from a different category (e.g., a stuffed animal) is shown to the infant.
  + Infants as young as 4 months orient towards the novel stimulus.
* Neuroimaging studies of the oddball procedure suggest that orientation is accomplished by the extrastriate cortex and the posterior parietal lobe, areas of the brain associated with selective attention in older children and adults.

***In Depth: Awareness and Visual Consciousness***

* Philosophers argue endlessly over the paradox in which neural processes of seeing do not resemble the subjective experience of seeing, leading neuroscience to examine whether we can find the neural correlates of consciousness.
* Vision and attention provide great ways of examining the neural correlates of consciousness.
* Perceptual bistability and blindsight are two phenomena that can tell us about awareness and vision.

Perceptual Bistability

* **Perceptual bistability** is a phenomenon in which a static visual image leads to alternating perceptions.
* It occurs in a number of common illusions, such as the Necker cube, the rabbit-duck image, and faces-vase image.
* A striking example of perceptual bistability comes from the phenomenon known as **binocular rivalry**, which occurs when a separate image is presented to each eye.
  + Binocular rivalry illustrates that our visual system is set up to see a single perception of the world. Thus, when each eye is seeing a completely different image, it inhibits one perception, rather than creating a double image.
  + It also illustrates the top-down processing of perception. We usually see the more “important” image than the less important image.

Blindsight

* **Blindsight** refers to the residual ability to make visual responses when a patient is subjectively blind in certain regions of his or her visual field.
* Paradoxically, patients make visual responses to stimuli they cannot see.
* Blindsight occurs primarily in patients with damage to V1.
* Lawrence Weiskrantz, a pioneer in blindsight research, hypothesized that blindsight can be explained by the alternate routes of neurons leaving from the retinae, such as the route from the retinae to the superior colliculus.