Optical Illusions: What Are They, and Why Do They Occur?

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Abstract

Optical illusions are commonly used in psychology classes in order to show how the brain can be easily manipulated. These illusions all target different parts of the visual pathway. As a result, researchers are able to find the specific reasons for some illusions, such as the Hermann Grid. However, scientists currently have no specific reason that all illusions trick us. As further research is done, optical illusions will be better understood, and scientists will be able to use them to further understand the visual pathway.

Introduction

Very often, people will claim to see things that do not exist. Whether that could be witnessing a mythical creature or losing track of a bug, our brain and eyes can often play tricks on us. One common trick played on our senses are optical illusions. Optical illusions, also called visual illusions, are a phenomenon that occurs when the perception of something differs from the actual reality of it (Yoshimoto, et al. 2021). Some commonly discussed optical illusions are the Hermann Grid Illusion, the Kanizsa Triangle, and the Lilac Chaser. These visual illusions play differing tricks on your mind, making you see motion and shapes where there are neither.

There are a multitude of possible reasons why optical illusions continue to play tricks on our mind. While each optical illusion is different in its effects on the brain, there are a few theories as to why these images fool our brains into seeing such differences from reality.

Visual Cue Pathway

The visual processing system is an incredibly complex pathway with many different parts of the brain and the eye involved. It begins when light enters the eye. From the iris and lens, light will be projected onto the retina. The retina is a very important part of the visual system as it determines the type of image that will be seen.

Inside of the retina, there are two different types of photoreceptors: rods and cones. Rods are located on the periphery of the retina, and assist in the processing of images in low light and in black and white. On the contrary, cones are found in the center of the retina and process images in higher light with different colors.

From the retina, a cranial nerve known as the optic nerve receives the information. This information is passed through until it reaches the optic chiasm. The optic chiasm is the intersection between the two optic nerves that allows for information from the left eye field and right eye field to be sent to both sides of the brain. Without it, our brain would only receive half of our visual information and would not be able to function as properly.

Once the information passes the optic chiasm, it continues to the lateral geniculate nucleus, which is a part of the thalamus. All sensory information passes through the thalamus, and then visual information is finally passed to the visual cortex. The visual cortex is where the images from the retina finally begin to be processed and are recognized by our brain (Baskin 2021). The complexity of the visual processing pathway leads to the possibility of error at any point. Different optical illusions target different parts of the pathway in order to have the effect that they do.

Hermann Grid Illusion

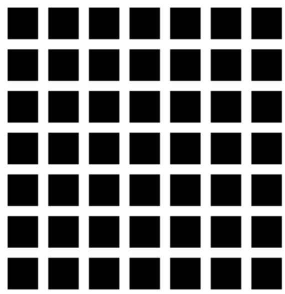

Figure 1. Hermann Grid Illusion. Black squares are separated by white lines. When staring at white lines, there seem to be gray circles in the intersection of the white lines where there are not (University of Pittsburgh, 2019).

One famous example of an optical illusion is the Hermann Grid Illusion. As seen in Figure 1, this illusion tricks the brain into believing there are gray circles located in the intersections of white lines. These circles are seen due to the posterior and anterior neuron connection.

Posterior neurons convert light stimuli into electrochemical messages. These messages are then sent to the anterior neurons, also known as ganglion cells. These ganglion cells are tasked with deciphering all the information they receive; the inputs that these ganglion cells receive are either excitatory or inhibitory. From there, they decide how best to transfer the information to other parts of the brain. Their decisions result in the unique organization of ganglion cells, which is often known as center surround.

When one views the Hermann Grid Illusion, ganglion cells are activated. The first ganglion cell (referred to as ganglion one) has 10 out of 16 of its inputs exposed to light.

Of these 10 inputs, eight of them are excitatory and two are inhibitory. The two inhibitory inputs are canceled out by the excitatory inputs, leading to a net gain of six excitatory inputs. Due to the increased amount of excitatory inputs in comparison to inhibitory inputs, the white line seems very bright.

The second ganglion cell (referred to as ganglion two) has no excitement at all. Due to not having any inhibitory inputs or excitatory inputs, the surround is repressed, and the center is not excited. As a result, the black background is shown as very dark.

Finally, the third ganglion cell (referred to as ganglion three) has 12 out of 16 inputs exposed to light. Out of these 12, eight are excitatory and four are inhibitory. As a result, the net result is four excitatory inputs, so the intersections between the white lines seem darker than the lines themselves. As a result, they are processed as a light gray color, tricking our brains into believing that the intersections are a darker color than the rest of the lines (University of Pittsburgh, 2019).

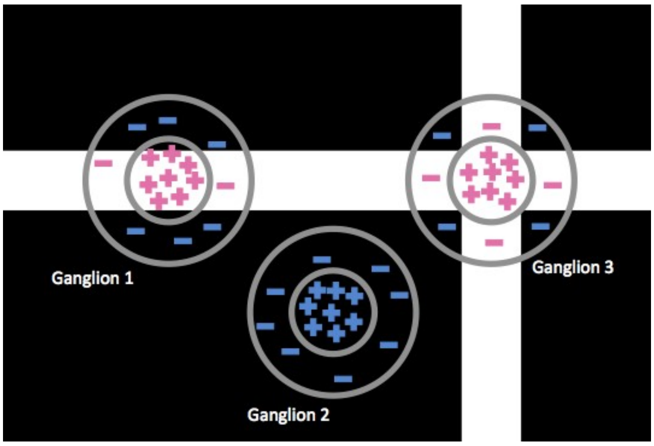

Figure 2. Hermann Grid Illusion. Black squares are separated by white lines. When staring at white lines, there seem to be gray circles in the intersection of the white lines where there are not (University of Pittsburgh, 2019).

While the Hermann Grid Illusion is easily explainable, this is simply one example of an optical illusion. There are many different types of illusions that all affect different parts of the brain. Despite this example, scientists still do not have specific answers as to why all optical illusions occur in the way that they do.

Theories on Optical Illusions

While there is information regarding specific illusions, scientists do not know what truly causes optical illusions (van der Berg 2019). However, scientists have a few theories. One reigning theory is the backward processing theory. This theory states that information travels through circuits of neurons. Usually, all this information is processed through the visual pathway and then passed on to the prefrontal cortex for decision-making. However, scientists believe that not all the information stays on this path, and some neurons change course by sending information back to the first stage of processing. This theory accounts for the processing of the Kanizsa Triangle, specifically (Duffy, 2016).

Another popular theory is that our brain simply misunderstands the signals it is being given by the eyes. Sometimes the visual cues are not enough to provide the necessary information for the brain to function properly, so some assumptions are made in order to maintain normal processing. As a result, some scientists believe that optical illusions are caused by a lack of information or a misinterpretation of the visual cues by the brain (van der Berg 2019).

Summary

Optical illusions occur when the brain incorrectly perceives images. These illusions manipulate different parts of the visual information pathway, and as a result, scientists are unable to figure out why exactly optical illusions occur. While researchers know how and where specific illusions like the Hermann Grid Illusion occur, they have two reigning theories as to why these occur on a broader scale: the backwards processing theory and the misunderstanding theory. Understanding optical illusions is crucial to the understanding of the visual pathway and all the issues that can occur during processing. With time, we will be able to better understand how the body perceives visual signals.

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