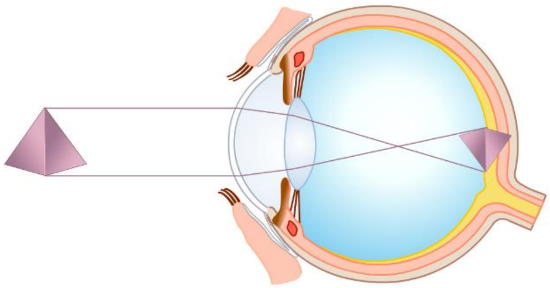
Seeing and recognizing

Our society relies heavily on visual perception. People orient themselves in the world primarily using their sense of sight. That's why our entire culture and civilization is heavily based on visual communication, from cave painting long ago to the written language and modern information and data technology, such as sending videos using smartphones.

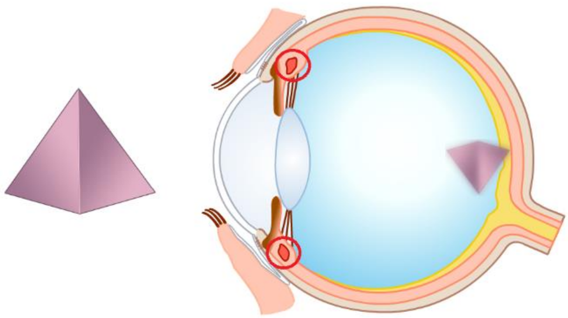
A brief summary of the most important facts related to the seeing process is provided below.

Formation of an image on the retina



The eye works like a camera lens: Ambient light passes through the cornea, the pupil, the lens, and the transparent vitreous body, after which it impinges on the light-sensitive layer, the retina. The sensory cells in the retina convert the light signals to electrical impulses that are transmitted to the brain via the optic nerve.

Accommodation



The term "accommodation" is used to refer to the adaptation of the eye for near vision or long-distance vision. The focal length of the lens is changed in order to adapt to the distance of objects: If you look at close objects, the ciliary muscle contracts and the lens becomes more rounded. If you look into the distance, the ciliary muscle relaxes and the lens becomes flatter.
This is how you focus on near and far objects.

Seeing colors and brightness levels

The retina is the light-sensitive layer of the eye containing the rod and cone cells. The rods recognize differences in brightness, while the cones recognize colors. There are three types of cones: cones that are sensitive to blue, cones that are sensitive to green, and cones that are sensitive to red. In the center of the retina is the point of sharpest vision, the "macula," with an especially large number of cones.
Light impulses are transmitted as electrical impulses to the brain, which is where the perception of vision occurs.

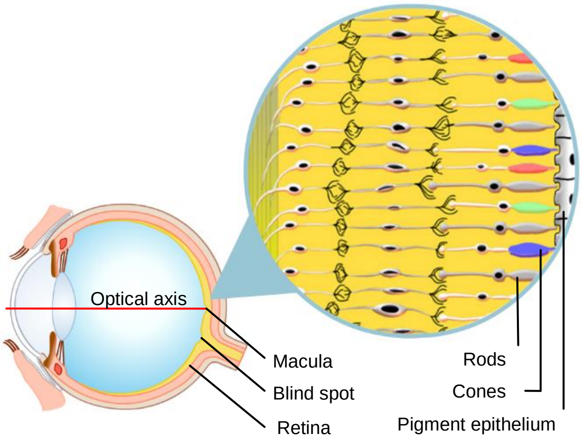


Image evaluation and pattern recognition

The picture on the right is very indistinct, but we still recognize what it represents, right?

How can that be? What the eye sees is not perceived and evaluated until it reaches the brain. The eye converts the incoming light into electrical impulses in the sensory cells and transmits the impulses to the brain via the optic nerve. The brain then processes the visual impressions in three phases: global evaluation, detailed evaluation, and elaborative evaluation.
At first glance, the observer obtains an overall impression and generally does not perceive any details yet.
Initially, only the contours (outlines, edges, differences between bright and dark) are evaluated. Then more details are evaluated, if necessary, and pattern recognition is further refined.

Intelligent evaluation

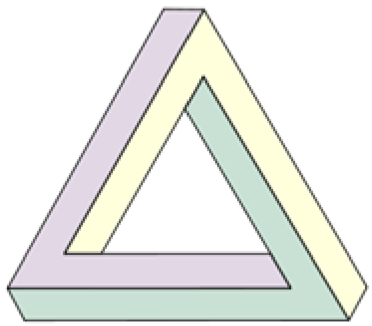
Visual information is immediately categorized subconsciously: that is, it's assigned to a general topic such as landscape, animal, or face. In addition, the information is assigned to a pattern called up from a wealth of experience. The images perceived by the eye are therefore recognized at least roughly by comparing them with patterns.
The subsequent step is the actual process of intelligent evaluation. The pattern seen is compared with knowledge and experience at the abstract conceptualization level using many areas of the brain: for example, we recognize a mixed forest in the fall, a family of long-tailed monkeys, or in this case, the cows in a meadow. This also helps us, for example, with our incredibly fast recognition of letters and words when we read. The individual word or whole sequences of words are first recognized quickly as a pattern, without the use of intelligence, and then the meaning is understood using our intelligence.

Optical illusions

Optical illusions take advantage of various “weaknesses” during intelligent evaluation. This makes looking at optical illusions very intriguing. The human brain is trained to recognize patterns based on a wealth of experience. That’s why, for example, you can identify a chair as such. We have learned that a chair consists of a seat, a back, and chair legs. If we then see a structure built in this way, we know from experience that it’s a chair. In everyday life, pattern recognition is helpful because it allows us to quickly categorize objects, among other functions.
In the case of optical illusions, we misinterpret what we see.

The Penrose triangle

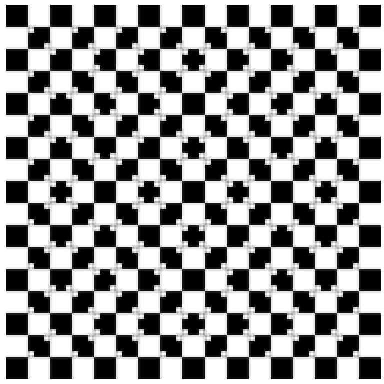
The triangle shown here is also called the “impossible figure.” Everyone knows what a triangle looks like in two-dimensional space. The problem here is that the three bars of the triangle are at right angles to each other and so create an impression of three-dimensionality. From experience, we know that such a triangle can’t exist. However, our brain can’t reach a conclusion and jumps from one possible interpretation to the next; in the process, it looks at all of the corners in succession.



From user: Bromskloss – Raster image w:Image:Penrose triangle.png was the model for this vector image, public domain, license: CC0, source: https://commons.wikimedia.org/w/index.php?curid=1287003

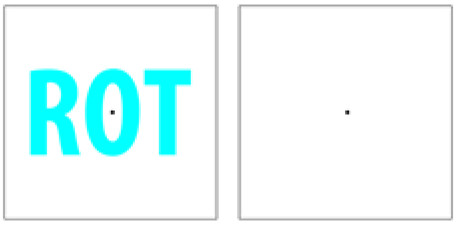
The relativity of lines

In the checkerboard pattern, the lines look curved. However, if you place a ruler on it, you’ll see that all the lines are straight and parallel.
The irregular impression is created by the small white fields, which cause our brain to think it recognizes plasticity (or deformation of straight lines).



From Bernard Ladenthin (own work) [public domain], via Wikimedia Commons, license: CC0, source: https://commons.wikimedia.org/wiki/File:Straightlines.svg?uselang=de

Afterimage



Focus on the small dot inside the “O” in the left image for 30 seconds. Then look at the small dot on the right side. What do you see?

In the right-hand image, the colors are opposite. The blue lettering appears red in the empty square.

This afterimage occurs as a result of looking at the colors for an extended time. The cones that are responsible for seeing colors become “fatigued.” If you look at the white surface, the “fatigued” and the “fresh” cones interact and you see the complementary color.