Illusions: The Magic Eye of Perception

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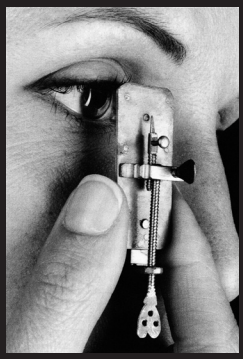

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Illusions: The Magic Eye of Perception

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Abstract

This paper focuses on the abilities of visualisation and spatial reasoning, based on studies of human perception and the associative structures that are formed in the memory. Perception is an activity of the brain that allows us to apprehend a situation objectively when stimulated by the senses. It is an inherently ambiguous process, where perceptual discrepancies may arise in different individuals who experience identical stimulation. These variations can be caused by different factors – optical, sensory or cognitive – and are called 'illusions'. All the senses can be confused by illusions. The focus of this study is the visual illusions that 'trick' the human visual system, causing it to see something that is not present or to see it in a misleading way. Visual illusions are useful tools for investigating the cognitive processes associated with perception and memory.

The construction of three-dimensional vision

Although human beings possess five basic sensory systems – sight, hearing, smell, taste and touch – the sense they trust and depend on most is vision as it provides the most essential information for interpreting the outside world. Physiologically, the left eye and the right eye always see slightly different images, but the mind gathers together the received stimuli and interprets them as a single image. This visual difference is exactly what enables volumetric perception and spatial location, identifying what is ahead or behind. The philosopher and cognitive scientist Zenon Pylyshyn (2003, p. 1) claims that despite progress in the study of the organs of vision and visual perception, how we see and why we see as we do has not yet been fully explained. According to Pylyshyn, we know there is a close relationship between the content of the mind and visual perception, but the nature of consciousness is not fully understood. To comprehend the cognitive process effectively, observations of a scientific nature concerning the organ of sight should not be taken in isolation but integrated with the study of other functions of the mind.

Pawan Sinha (2009), another expert on vision and neuroscience, states that formerly blind patients can sometimes recover, even if they have experienced great visual deprivation. He cites an example of children with congenital cataracts who undergo surgery to replace their own opaque lenses with acrylic lenses that restore some element of vision. Nevertheless, this late development of vision hinders the identification of objects: Sinha's research found that these problems occur because the patient's world appears to them as fractured, as if formed out of separate pieces. He concludes that visual coordination needs to receive information in a dynamic manner because the processing of the moving image serves as a foundation for visual integration and recognition.

From these studies, it can be understood that the brain has to be conditioned, and this requires training the eye to understand physical space. This cognition training is an essential part of the perceptual process. According to Pinker (1997), we deal with this reality because our thoughts and actions are guided by a stable and solid knowledge built up over the years. In other words, the mind needs to be ed-

ucated to become an instrument of cognition that understands forms and spaces. The British neurologist Oliver Sacks (2010) reports studies of several patients who had difficulties of visual recognition, and similarly concludes that humans appear to need some kind of learning process through which they acquire the knowledge of codes or conventions that helps them recognise objects. According to Sacks, people from primitive cultures who have never seen photographs cannot distinguish between images – the complex system necessary for the recognition of visual representations has to be specially constructed by the brain. It is therefore important to learn how objects are represented in two dimensions.

Mental representations of memory

Another important point to note is that there is a difference between what you see and the image that the mind 'builds'. Nothing that is observed is understood only through the sense of sight; the brain and the senses directly interfere with what is perceived. Furthermore, human beings use their memory to make associations in order to recognise what they see. This innate ability to make associations assists with troubleshooting when information from what is observed is incomplete by adding idealised assumptions to solve the visual puzzle. Although no one has a perfect memory, we are able to generate new possibilities for analysis and creation: "The brain is a good computer, simply by being a bad memory. It is this bad memory that fuels the process of computing" (de Bono, 1968, p. 9).

However, memory also creates difficulties: individuals in the same situation will differ in the information they provide for themselves when supplementing the process of recognition of something they observe. This can be easily proven with an unfinished drawing where the observer's imagination supplements the incomplete visual information, indicating that perception is directly related to memory. On the one hand, it is difficult to describe accurately something that is observed; on the other, is easy to describe a mental image in detail. The role of such structures of thought was analyed by Francis Galton in 1883. According to Galton, the faculty of vivid visualisation is of great importance in the stimulation of generalised thinking.

Another author who has studied the value of the mental image is the American psychologist Stephen Kosslyn (1996). He has theorised that these mental images are essentially spatial and organised as shapes, and are therefore inseparable. This indicates that reasoning often needs images in order to solve problems. Kosslyn proves this by asking questions such as: "What is the shape of Mickey Mouse's ears?" or "Which colour of green is darker, that of a frozen pea or a pine tree?" Mental representations are therefore mental structures that give meaning to the perceptions, thoughts and actions of a human being.

A puzzle about perception: the visual world and illusions

Arnheim (1997) argues that perception and thought maintain an unbreakable relationship; there is a permanent link between them, and the separation of these processes is an artifice that leads to an incomplete interpretation of human beings and their interaction with the world. According to Arnheim, the human being perceives the environment based on the interaction between aspects of perception and the internal structures of thought. The perceptual universe is therefore not only an impression formed out of a combination of passive sensory elements, but also involves active organisation, as the human brain seeks to form an experience consistent with the its known reality. Different geographical locations, cultures and societies produce variations of the perceived world.

According to the German physician and physicist Hermann von Helmholtz (1910), our perception is constructed through inferences unconsciously made about the world. These inferences contrast with the information that the body collects from the environment. This cooperative action of the senses allows human beings to build a consistent, realistic framework that is useful for interpreting the physical environment that surrounds them. There is a trend towards the integration of the stimuli from the various senses, so when discrepancies occur in a real physical situation, as in the case of illusions, our sensory system tries to 'correct' the mistake to accommodate the situation. This is achieved by adjusting the group of sensations that have been detected so as to create new inferences and test new conjectures. Just as an analogue computer performs arithmetic operations by means of finding the similarity between quantities, the 'analogue computer' of the human brain forms new images that can be used in a similar situation. The perception is not necessarily consistent with the existing reality – the imagination is full of perceptions. "[S]ometimes we cannot perceive what does exist. At other times, however, we perceive things that do not exist" (Sternberg, 2009, p. 112).

An illusion is a confusion of the senses that distorts perception. However, almost all perceptions are illusory. Appearances are deceptive in many ways: when we look at the sun, for example, we have the illusion that it revolves around the earth, yet the reality is the reverse. Anyone can make a mistake, even under normal conditions. Take the example of fig. 1, the *Ames Room*, created by the painter and psychologist Adelbert Ames Jr. in 1946, and based on a concept of von Helmholtz. Ames recreated a distorted room that, when observed from a unique position, makes people or objects seem to increase or decrease in size as they move from one corner of the room to the other.

Ames's idea was to align an irregular form in order to produce a regular image – that is, to distort reality in order to create a visual illusion that represents something as 'right'.

Illusions can be occasioned by different causes: they can be generated by physiological deficiency, by the misuse of knowledge or by physical interference. They can arise naturally or be created by a specific visual trick, but the result of the interpretation or misreading of the sensory signals is the same – an illusion. The cognitive illusion shows that learning is funda-

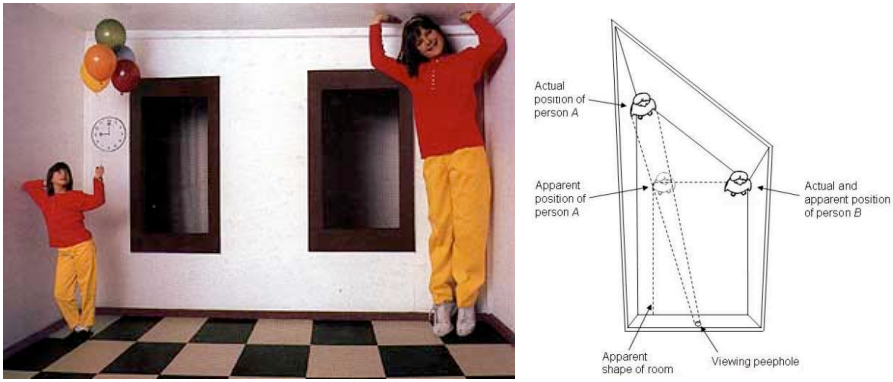

Figure 1: Ames room. The front view, from a certain angle, the space appears to have the shape of a cube, but in fact its shape is trapezoidal.

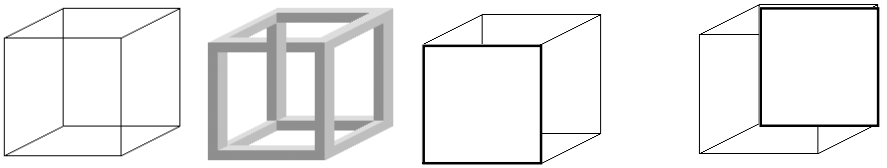

Figure 2 – (Left) A-Necker cube (Right) B-Ambiguity. Source: (Left) http:// diascomsol. Multiply.com (Right) WWW.professorglobal.cbpf.br

mental. Take the example of fig. 2 (A). Any human being with some elementary knowledge of geometry will say they see a cube. However, perhaps a more accurate description would be 'sixteen line segments, four vertical, four horizontal and four oblique, combined in a particular configuration'. This may be a strange description, but surely a cube is a solid three-dimensional object? So how can it be represented as a two-dimensional surface?

This classic representation of the real world as a plane can be explained because the image projected onto our retinas is two-dimensional. Only after interacting with, and learning about, the world around us can we understand that this representation on a flat surface corresponds to the vision of an actual cube. However, every projection of a three-dimensional object over a two-dimensional surface is already in itself a visual illusion. Ambiguity is another perceptual phenomenon that can be observed

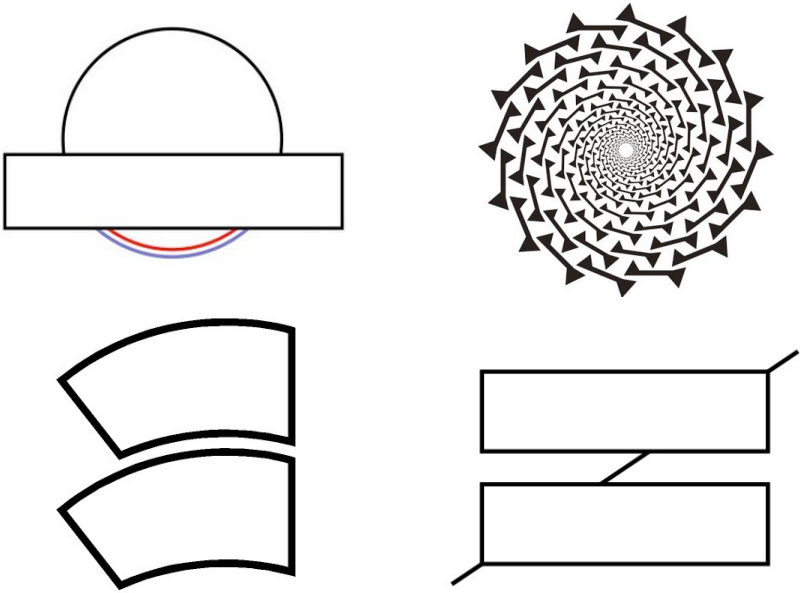

Figure 3 – (A) Which of the lines complete the circle? (B) It is a true spiral?(C) What is the size relationship between the forms? (D) The line behind the rectangles is a straight line?

from the same image of the cube. Look at fig. 2 (B): which line is in front and which behind? The representation can be interpreted in two different ways – both are valid. This phenomenon shows that the same image on the retina may correspond to two or more objects, and also that the same object can induce the construction of two or more different perceptions.

Many visual illusions involve spatial relationships, and this can lead to errors in dimension, curvature and direction. These errors are called 'geometric illusions' (fig. 3). There are particular illusions involved with lines – the vertical lines always seem larger than the horizontal ones. This can be explained physiologically: it is easier for our eyes to perform a horizontal movement than a vertical oscillation.

Another aspect of visual illusion is that we perceive surfaces involuntarily. Human beings are impelled to 'see' even though the image is not fully drawn. These illusions are virtually present because we represent the whole image in our consciousness at once. One example is the illusion described by the Italian psychologist Gaetano Kanizsa in 1955. Take the example of fig. 4: the brain interprets the image as two equilateral triangles, a white one above another represented with a black outline. In reality, however, none of the triangles are drawn. This effect is known as a 'subjective illusion' or 'illusory contours'. One explanation for this illusion is that the perception of the whole is greater than the sum of the parts; the mind seeks simplicity and cohesion.

Illusions are not a disorder of perception but the result of the combination of physiological stimuli with mental associations. It is precisely this aspect of perception that provides one of the most important characteristics of illusions: they offer us a kind of 'magic eye' that allows us to study the deeper mechanisms of perception and the function of the human visual system.

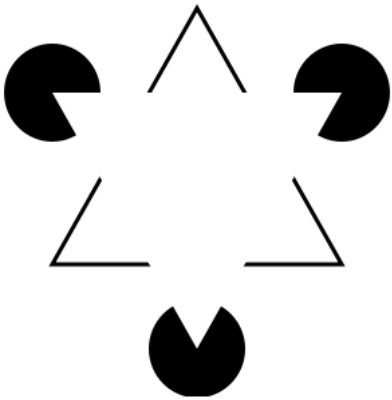

Figure 4 – Kanizsa Triangle. Source: http://toatoanal-agoa.blogspot.com

Conclusion

The most mysterious of all brain phenomena is consciousness, especially when related to sensations and their possible uses. Normally, human beings do not realise that much of what they see around them every day is in fact an active construction of their minds. It is known that consciousness acts in the capacity of perception, and this largely depends on the knowledge and past experiences of the individual. This knowledge, derived from the past, can directly interfere with the perception of the present moment. However, consciousness identifies the present situation by distinguishing what comes from memory.

The main sensory system that directly assists in perception is vision. Human beings believe in what they see, and that is why visual illusions fascinate them. However, these illusions generate some discomfort due to the constant quest to understand and explain what is presented to us. Illusions show something that does not actually exist, or they distort vision, leading to erroneous interpretations of situations because their construction is based on a misconception. The mind tries to restore the correct,

concrete object represented, even in the case of images that are shown to be physically impossible when recreated in three dimensions. Thus, human beings use rules they learn from the world around them (which they trust). In the final analysis, illusions are not errors of perception, but result from the intimate and daily construction of the mechanism of perception. These illusions depend on cognitive factors combined with the interaction of the senses with the environment. These factors are shaped by individual experience, which allows for the creation of new mental arrangements.

The exercise of observing and understanding illusions requires reasoning ability, memory and an optical apparatus trained to see in three dimensions. Illusions symbolise the magic of appearances, and their representations are constructed by omitting parts of the whole or by using ambiguous figures. The brain succumbs to the illusion and the imagination does the rest. The study of illusion has opened several 'windows' that allow the penetration of some of our perceptual mechanisms and their correlated processes, such as those related to visual attention and the ability to form graphic representations.

References:

Arnheim, R. (1997) *Visual Thinking.* Los Angeles: University of California Press.

De Bono, E. (1968) *The Mechanism of Mind*. (8th ed.). London: J. & A. Churchill.

Galton, F. (1883) *Inquiries into Human Faculty and its Development*. London: J.M. Dent & Company.

Gardner, H. (1985) *The Mind's New Science: A History of the Cognitive Revolution*. New York: Basic Books.

Kosslyn, S. (1996) *Image and Brain: The Resolution of the Imagery Debate.* Cambridge, MA: Bradford Books, MIT Press.

Pinker, S. (1997) *How the Minds Works*. London: W.W. Norton & Company.

Pylyshyn, Z. (2003) *Seeing and Visualizing: It's Not What You Think*. Cambridge, MA: Bradford Books, MIT Press.

Sacks, O. (2010) *The Mind's Eye*. New York: Vintage Books. Available : http://pt.scribd.com/doc/50129661/O-Olhar-Da-Mente-Oliver-Sacks (Accessed 12 March 2013).

Sinha, P. (2009) *On How Brains Learn To See* [Download]Available at: http://www.ted.com/talks/pawan_sinha_on_how_brains_learn_to_see.html (Accessed 10 March 2013).

Sternberg, R. J. (2009) *Cognitive Psychology*. USA: Wadsworth Cengage Learning. Available at: http://books.google.co.uk/books?id=WNss-44HFUQC&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false (Accessed 12 April 2013).

Von Helmholtz, H. (1910) *Treatise on Physiological Optics*. New York: Dover.

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