The Hyperbolic Vision in Humans and Other Animals

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Abstract: ***The conical perspective (linear, central) is the one that interests us in hyperbolic medicine. When humans observe an object, the conical perspective that we perceive of that image is not parallel lines that converge at a point, but rather hyperbolic curves of space - time. The objective of this work is to study how other animals, not humans, see these hyperbolic space - time curves. We selected information about vision in animals and studied the possibility of hyperbolic perception as it happens in humans. Conic perspective represents images that travel at the speed of light to the eye of the observer, following hyperbolic curves of space - time. Human vision is hyperbolic because the space in which we live is deformed by "general hyperbolic curves" that exist at any longitude and latitude of the Earth's geography. The hyperbolic images that animals perceive are different according to the species. That depends on the number and position of eyes on your body, as well as the type of rods and cones you have in the eyes. Animals with binocular vision have their perception in the furthest part of a hyperbolic image, whereas animals with lateral vision have it in the closest part of that hyperbolic image.***

Keywords: hyperbolic, medicine, space - time, human, animals, perspective

1. Introduction

There are three concepts to consider:

a) A "hyperbolic curve" is an open geometric figure with two branches, obtained by cutting a right cone through a plane oblique to the axis of symmetry. The plane does not have to be parallel to the axis of the cone, and the hyperbola will be symmetric in any case [1] (Figure 1).

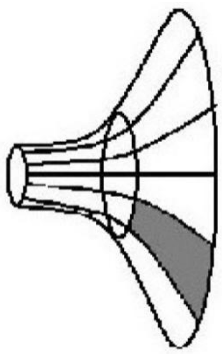

Figure 1: Hyperbolic image

b) We call "Hyperbolic Medicine" (abbreviated "Medipérbola") to the study of hyperbolic curves that occur in the physiology of a living being, especially in humans, about other hyperbolic curves that may be in nature, such as fields electromagnetic, expansion - contraction systems in motion, circadian rhythms and space - time relativity [2 - 4].

c) A "perspective" is a form of representing objects in such a way that they are visualized from the observer's point of view. Using this technique, a three - dimensional (3D) space is represented onto a two - dimensional (2D) surface. Perspective helps us create a sense of depth, giving an effect of volume to objects [5]. The eye estimates the distance taking into account the decrease in the size of the objects and the angle of convergence of the lines (linear perspective) [5]. There are many types of perspectives, but the conical perspective (linear, central) is the one that interests us in hyperbolic medicine since it is the one that most closely approximates thevision in humans. Objects get smaller as their distance from the observer increases [6]. Photographs give these types of perspectives when they collect the projected image [6 - 11].

It has been suggested that the human eye perceives the space around us as a hyperbola [12]. Hyperbolic curves are very frequent in human physiology and nature [2, 13]. In a simple magnet and the Earth's magnetic field, there are lines of force that follow a hyperbolic pattern [14, 15]. According to previous studies, the closest houses are perceived larger than the ones further away because the trajectory of these images to the observer's eye does not go in a straight line, but rather through a hyperbolic curved line that is similar to the lines of force of a magnetic field. The images of nature are hyperbolas because the deformed space in which we live is hyperbolic [2, 3, 13, 16 - 20]. It has been described that, when humans observe an object, the conical perspective that we perceive of that image is not parallel lines that converge at a point, but rather hyperbolic curves of space - time [4] (Figure 2).

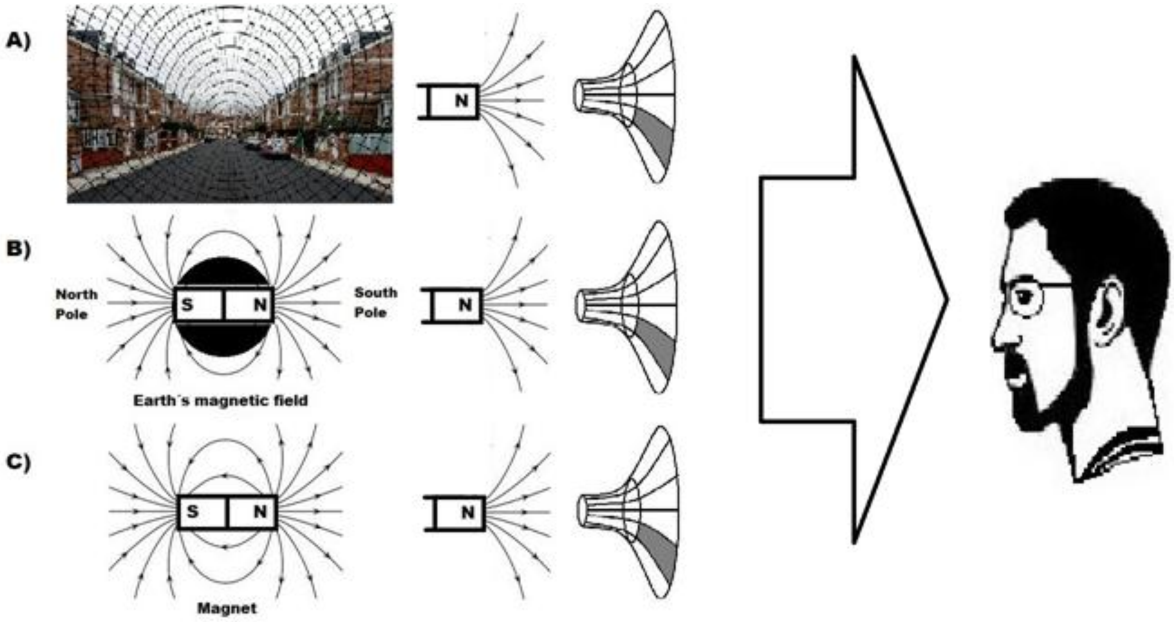

Figure 2: Conical perspective on a street in Salamanca (Spain). The houses farthest from the observer are smaller for him because he sees a hyperbolic image (A). The lines of force of the Earth's magnetic field (B) and a magnet (C) are also hyperbolic images.

According to the Theory of Relativity, an object that moves on an X - axis, perpendicular to the line of sight of an observer, contracts that length X and its time is dilated, while its dimensions Y and Z, perpendicular to that direction of movement, are not altered [21, 22]. According to current studies, it is different if that object moves perpendicular to the line of sight of an observer, or if it approaches or moves away in the same line of sight [2, 13, 16 - 18]. These works indicate that when the object approaches an observer in the same line of sight, he perceives its height (Y) and width (Z) increasing in size. For that reason, he interprets that these dimensions Y and Z, perpendicular to the axial movement of the object, have been dilated. If the object moves away from the observer along the same line of sight, he perceives those dimensions Y and Z, perpendicular to the movement, each time smaller, for which he interprets that there is a contraction [2, 13, 16 - 18] (Table 1) (Figure 3).

Table 1: The classical Theory of Relativity and the results of a previous study by the author

Classical theory of Relativity . Object moves perpendicular to the observer´s line of sight	Length X parallel to the axis of movement contracts by a factor K= $\sqrt{1-v^2/c^2}$
	Time t_x parallel to the axis of movement dilates by a factor K= $\frac{1}{\sqrt{1-v^2/c^2}}$
Results of a previous study by the author. Object approaches or moves away from the observer in his same line of sight	Lengths Y and Z perpendicular to the axis of movement: * When the organ approaches the observer these lengths dilate by a factor K= $\frac{1}{\sqrt{1-v^2/c^2}}$ * When the organ moves away from the observer these lengths contract by a factor K= $\sqrt{1-v^2/c^2}$
	Times t_y and t_z perpendicular to the axis of movement: * When the organ approaches the observer these times contract by a factor K= $\sqrt{1-v^2/c^2}$ * When the organ moves away from the observer these times dilate by a factor K= $\frac{1}{\sqrt{1-v^2/c^2}}$

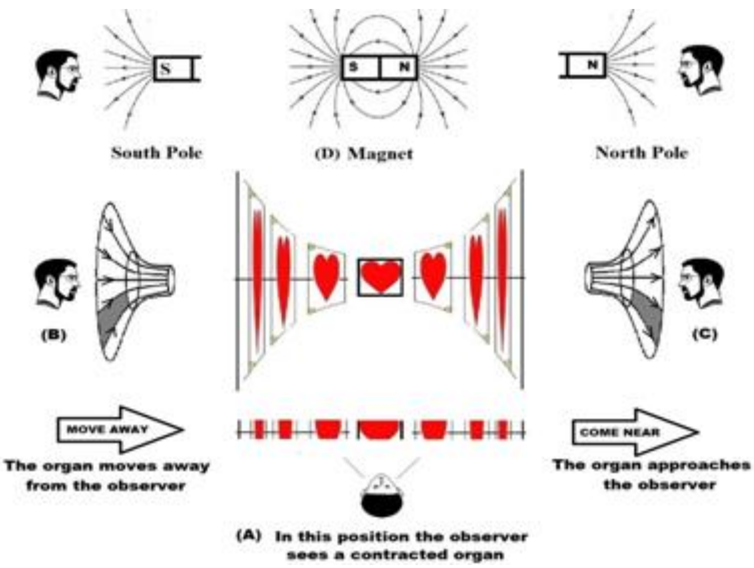

Figure 3: When an organ moves perpendicular to the observer's line of sight, he sees it contracted (A). If the organ is moving parallel to its line of sight, the observer sees a hyperbola moving away (B) or approaching (C). It is similar to the lines of force in a magnetic field (D). When this organ moves away from the observer, it follows the hyperbolic lines of force that

enter through the south pole of the magnet (B). If that organ gets closer, it follows the hyperbolic lines of force coming out of the north pole of the magnet (C).

In both cases, the observer perceives hyperbolic images, when the organ approaches or when it moves away. In previous works [16], the dilation factor perpendicular to the movement was calculated as $K=1/\sqrt{1 - v^2/c^2}$. If we transform it into $1/K^2=1 - v^2/c^2$ it gives us hyperbola in approach motion [13]. The contraction factor perpendicular to the movement, calculated as $K=\sqrt{1 - v^2/c^2}$ [16], can be transformed into $1/k^2=1 - c^2/v^2$, which is the hyperbola moving away [13]. It has been pointed out that when an organ moves away from the observer it does so according to the hyperbolic lines of force that enter through the south pole of a magnet [13]. When the organ approaches an observer, it does so according to the hyperbolic lines of force that emerge from the north pole of a magnet [13] (Figure 3).

In the retina, there are two types of photoreceptors: rods and cones. The rods are more sensitive to lack of light, they do not allow you to see in color, they are perceptible to movement and they give little image detail. The cones are activated in high light conditions, allow you to see in color, are sensitive to contrast, and give high image detail. When there is little light, vertebrates see black and white since the rods are activated, but the cones remain inactive [23, 24]. Cones are sensitive to different wavelengths, that is, to different colors. Every living being on our planet sees the world differently. Some see it in black and white, but others see colors not perceptible to the human eye [25]. They can see their hyperbolic world differently. The human perceives about 60 images per second, the dog perceives 80, and the common fly captures about 250. Our eyes have receptors for the colors red, green, and blue. Birds capture ultraviolet light, and stomatopod crustaceans (mantis shrimp) have 16 photoreceptors [26]. The number of colors that each animal species can see is determined by the adaptation of its eyes to capturing light, and the type of photoreceptor cells it has. Humans can see wavelengths from 380 to 750 nanometers (the colors of the rainbow). However, we cannot capture infrared light as some types of snakes do, or ultraviolet light as many insects do [27].

We think that the hyperbolic curves that humans see are also perceived by other animals. The objective of this work is to study how other animals, not humans, see these hyperbolic space - time curves.

2. Material and methods

In Internet search engines and various databases (Medline, Scielo), we made a bibliographic review of scientific works on conical perspective, hyperbolic curves in medicine, and space - time perpendicular to the movement of an organ. We selected information about vision in animals and studied the possibility of hyperbolic perception as it happens in humans.

3. Results

1) The conical perspective is the one that most closely approximates the vision of the human, and it forms a conical bundle of parallel lines, which converge at some point in the representation (Figure 1) [5 - 11]. According to previous works, these parallel lines are hyperbolic curves [4].
2) There are numerous works that relate human vision with images of hyperbolic curves [2 - 4, 13, 16 - 20] (Figures 2 and 3). In nature, images are hyperbolas and exist in any longitude and latitude of the Earth where they are observed [3].
3) There is space - time relativity, perpendicular to the axis of movement of an organ, which gives hyperbolic curves [2, 13, 16 - 18] (Table 1).
4) Binocular (stereoscopic) vision allows a correct calculation of distances, although the field of vision is smaller. When you have two eyes in a frontal position you have a more accurate perception of depth. If you take images separately in each eye, from slightly different positions, the brain can reconstruct the distance and give the depth. The images from both eyes are superimposed to create a single three - dimensional image [23, 24, 28, 29]. The number of eyes of the animal and their position in the body allows him to calculate spatial dimensions [29] (Table 2).

Table 2: Vision, according to the number of eyes and the position in the animal

• Two front eyes: they allow to have binocular vision in three dimensions because the brain combines the different information that each eye captures. It occurs in men and most predators.
• Two lateral eyes: they allow a panoramic visual field, although with reduced visual acuity. It occurs in herbivores, fish, and many other animals that serve as prey.
• Five eyes: the starfish has one eye on each end of its arms. Some starfish have five arms, but others have about forty.
• Eight eyes: most spiders have eight eyes, but others have six.
• Ten eyes: crabs have two eyes on the sides of their body, five on the back, two in the middle of their body, and one under their tail.
• - Fifty to one hundred eyes: clams have all those eyes around their body.

5) The shape and size of the pupil allow us to control the light that enters the eye. Compared with a round pupil, the elongated pupil opens and closes more because it opens to the sides [23]. The goat or horse has a horizontal pupil, while felines such as margay have a vertical pupil.
6) Animal vision can be classified according to the type of visual pigments that each species has [23, 24, 29] (Table 3).

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Table 3: Classification of vision, according to visual pigments

- Monochromatic: 1 type of cone. Examples: raccoons and salamanders.
- Dichromatic: 2 types of cones. It includes the vast majority of animals, such as dogs, wolves, cats, mice, goats, sheep, bulls, cows.
- Trichromatic: 3 types of cones. It is the case of man and primates.
- Tetrachromatic: 4 or more cones. Among which are birds, reptiles, and fish.

4. Discussion

The conical perspective has been widely studied in the Art, to represent three - dimensional images (3D) in a two - dimensional plane (2D). However, this is somewhat fictitious. A conical perspective image is a static image. It is a snapshot image. It has been described that when we see this image moving, the lines transform into curves, and we observe a hyperbola [2, 3, 13, 16 - 18]. The conic perspectives are hyperbolic space - time curves [4] (Figures2 and 3).

We know from previous works [3] that hyperbolic curves occur at any longitude and latitude of the Earth's geography. They are there. They are independent of other circumstances and therefore are "general hyperbolic curves". On the contrary, the Earth's magnetic field generates “local hyperbolic curves”, which can vary with time and even reverse their polarity [30].

All animals can perceive hyperbolic images, although different. The position of the eyes in mammals can be frontal, as in a cat, or lateral, as in a rabbit. In general, animals with their eyes facing forward, move their eyes together and have a more precise perception of depth [23, 24, 28, 29]. This binocular vision is typical of carnivores (generally predators), who must focus their attention on their prey, or primates who must calculate the distance between the branches of the trees [23, 24, 29]. In this case, the brain analyzes the disparity and parallelism of the images it receives to calculate the distances to the perceived object. In this way, the brain creates a hyperbolic image in a conical perspective. The brain also uses other depth signals to perceive three dimensions, such as the size of objects, overlap, focus, lighting, and shadows.

Side (or peripheral) vision allows each eye to send a different signal to the brain. This side visión is typical of herbivorous animals (generally prey animals). It allows them to more easily observe their surroundings because they have a field of vision of almost 360º. In this way, they can be attentive to the presence of predators [23, 24, 29]. Probably, in these lateral vision animals, the conical perspective of hyperbolic lines is achieved differently than in binocular vision animals. As we have commented before, the number of eyes and their disposition are not the only references to perceive this hyperbolic image. Perception in three dimensions could be calculated by relating object size, overlap, focus, lighting, and shadows. We must think that a spider has better integration of images because 6 - 8 eyes allow it to make a better calculation of distances.

The shape and size of an animal's pupil regulate the lighting perceived by the eye. It influences the perception of the three dimensions. The vertical pupil of some cats allows them to determine distances in depth. On the contrary, the horizontal pupil of some herbivores allows them to widen the visual field.

About hyperbolic vision, the type of visual pigments in each animal's eyes must also be considered. Light is an electromagnetic wave that can be broken down into colors. Some animals have cones that are sensitive to gray, yellow, and blue colors, such as dogs, wolves, and cats [23, 24, 29, 31]. Other animals, such as equines, see the colors blue and red [23, 31]. Raccoons, some types of snakes, and most rodents see only black and white [23, 25, 29, 31]. Goats, sheep, and cows have cones that are sensitive to green and blue colors [23, 29, 31]. Many animals perceive ultraviolet radiation, such as dogs, cats, rodents, pigs, cows, reindeer, and birds in general [23]. Daytime birds have four color receptors and perceive ultraviolet light as well as polarized light [25]. Bees have a lot of ommatidia, which are individual eyes within others, and allow them to differentiate yellow, green - blue, and blue, and also capture ultraviolet light [29, 31, 32]. Each animal species can perceive a part of the electromagnetic spectrum. It depends on the type of cones and rods that the animal has in its eyes. The presence of these anatomical elements modifies the way of visualizing the hyperbolic image that reaches your eyes, but it is something that has yet to be studied.

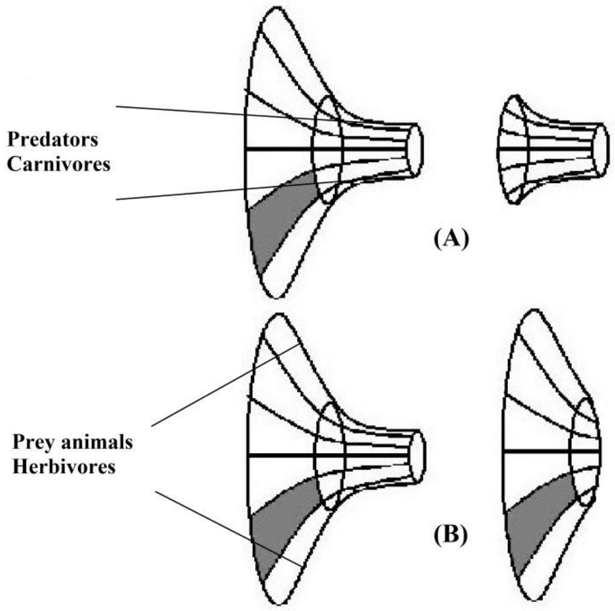

Figure 4: Animals with binocular vision perceive the farthest part of the hyperbolic image (A). Animals with lateral vision perceive the closest part of the hyperbolic image (B),

The animals that make the best calculations of spatial dimensions at distance are those that have binocular vision, more number of eyes, and more quantity of visual pigments. It allows them to see the farthest part of the hyperbolic image better (Figure 4A). On the contrary, animals with lateral vision, fewer eyes, and fewer visual pigments would better perceive the closest part of the hyperbolic image (Figure 4B).

5. Conclusions

1) Conic perspective represents images that travel at the speed of light to the eye of the observer, following hyperbolic curves of space - time.
2) Human vision is hyperbolic because the space in which we live is deformed by “general hyperbolic curves” that exist at any longitude and latitude of the Earth's geography.
3) The hyperbolic images that animals perceive are different according to the species. That depends on the number and position of eyes on your body, as well as the type of rods and cones you have in the eyes.
4) Animals with binocular vision have their perception in the furthest part of a hyperbolic image, whereas animals with lateral vision have it in the closest part of that hyperbolic image.

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