



## THREE DIMENSIONAL ILLUSTRATING - THREE-DIMENSIONAL VISION AND DECEPTION OF SENSIBILITY

Noémi Szállassy, Anita Gánóczy, György Kriska

**Abstract:** The wide-spread digital photography and computer use gave the opportunity for everyone to make three-dimensional pictures and to make them public. The new opportunities with three-dimensional techniques give chance for the birth of new artistic photographs. We present in detail the biological roots of three-dimensional visualization, the phenomena of movement parallax, which can be used efficiently in making three-dimensional graphics, the Zöllner- and Corridor-illusion. There are present in this paper the visual elements, which contribute to define a plane two-dimensional image in three-dimension: coherent lines, the covering, the measurement changes, the relative altitude state, the abatement of detail profusion, the shadings and the perspective effects of colors.

**Zusammenfassung:** Durch die weite Verbreitung der digitalen Fotografie und der Computertechnik ist es jedermann möglich, dreidimensionale Abbildungen zu erstellen und der Öffentlichkeit zugänglich zu machen. Mit den neuen dreidimensionalen Techniken stehen nun Verfahren zur Verfügung, mit denen sich völlig neuartige, künstlerisch gestaltete Fotografien herstellen lassen. Im vorliegenden Artikel erläutern wir eingehend die biologischen Grundlagen der dreidimensionalen Visualisierung, die Phänomene der parallaktischen Verschiebung, die sich effizient zur Erstellung dreidimensionaler Grafiken nutzen lassen, sowie den Zöllner- und den Korridor-Effekt. Weiterhin gehen wir auf jene visuellen Elemente ein, die ein ebenes, zweidimensionales Bild dreidimensional erscheinen lassen: Kohärente Linien, Überdeckung von Objekten, Variieren der Proportionen, Höhen-unterschiede, Verringerung der Detaildarstellung, Schattierung und schließlich perspektivische Effekte, die sich durch die Farbgebung erzielen lassen

**Key words:** three dimensional illustrating, perspective view

### 1. Introduction

In recent years such revolutionary changes have been made in the three-dimensional photography and illustrating methods that lead to new opportunities in education, using three-dimensional techniques. For example, today you can download from the internet free computer programs, which can help you put together your two-dimensional photographs into a three-dimensional picture without investing too much energy. These methods are so new that Hungarian and Romanian descriptions about them are very scattered, that's why few of the professional photographers know these techniques.

Earlier three-dimensional photography could be made only by artist who started using these methods with good theoretical basics and technical instincts. Yet their work of art became a treasure in exceptional cases because of the expensive and complicated three-dimensional illustrating methods.

The wide-spread digital photography and computer use gave the opportunity for everyone to make three-dimensional pictures and to make them public (Ferwerda, 2003).

The new opportunities with three-dimensional techniques not only give chance for the birth of new artistic photographs, they also contribute for the black and white photos underneath the drawers to come out in their new, spectacular forms, praising the expertness of their creator.

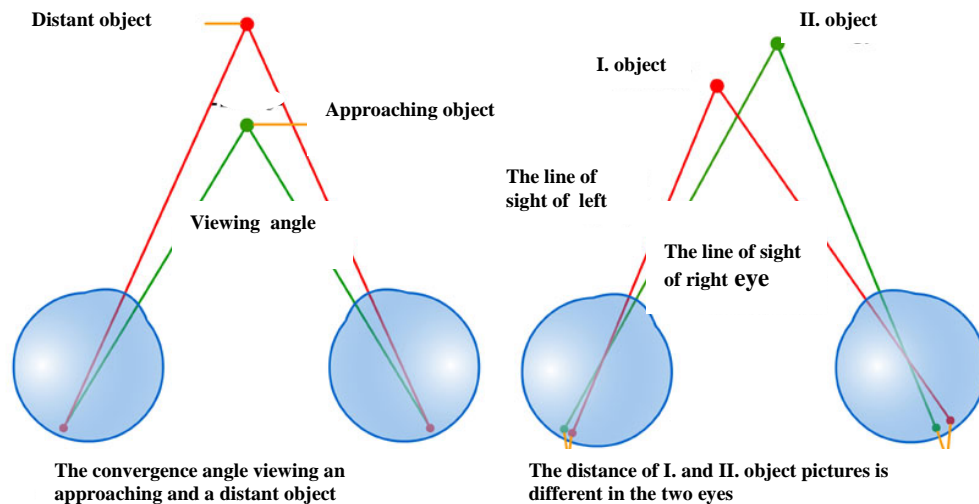
## 2. The biological roots of three-dimensional visualization

Our two eyes are situated at approximately 65 mm distance from one another, that's why the reflections of the not so overly distant objects on the retina are partially different, their perspectives differ (Snell, Lemp, 1998). From the eyes two-dimensional information are going along the nervous paths to the nervous system's visual center where the spatial resolution is made. In the configuration of spatial resolution near the stimulus from the retina, higher rate functions of the brain have the role of completing the picture, emphasizing certain elements, and by right of earlier visual and other sensory organ experiences creating the perception itself. (Kaufman, Alm, 2003).

The two conditions of three-dimensional eye vision (eyesight) are deep and distance perception, which components can be ranged into five groups. These are convergence, retinal disparity, accommodation, movement parallax and perspective sight.

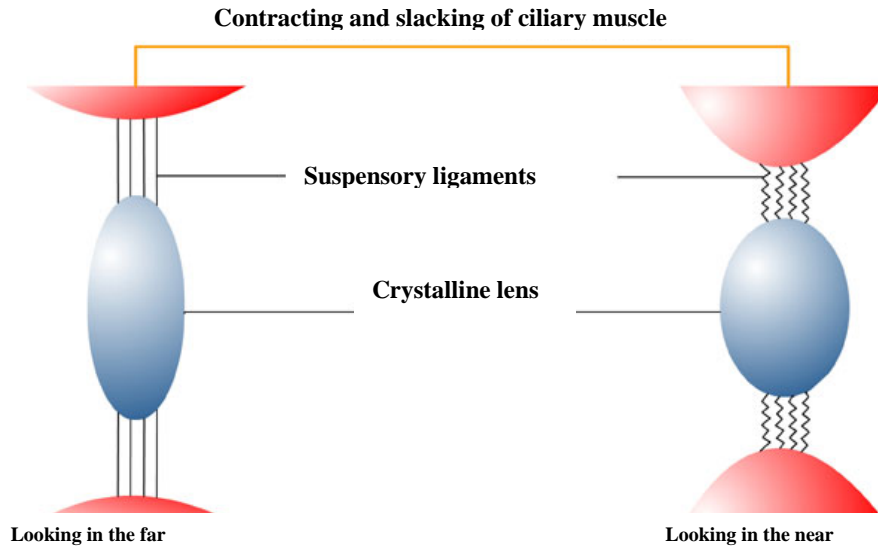
Convergence is the angle made by the line of sight of the two eyes, when we look at an object. If the object is far away from us the angle is smaller, if it's closer, the angle is bigger. By the measure of the angle of convergence our optical system's neural center concludes the distance of the object.

Retinal disparity is induced by geometrical causes. If we focus with our two eyes on the I. point, the image will be displayed on the same place of the retina in both eyes. If the II. point is farther than the I. point while focusing the image of the II. point will be reflected on several places on the right and left eyes retina (Figure 1). This deflection is percept (detected) by the optical system and uses to determinate the distance between the I. and the II. point.



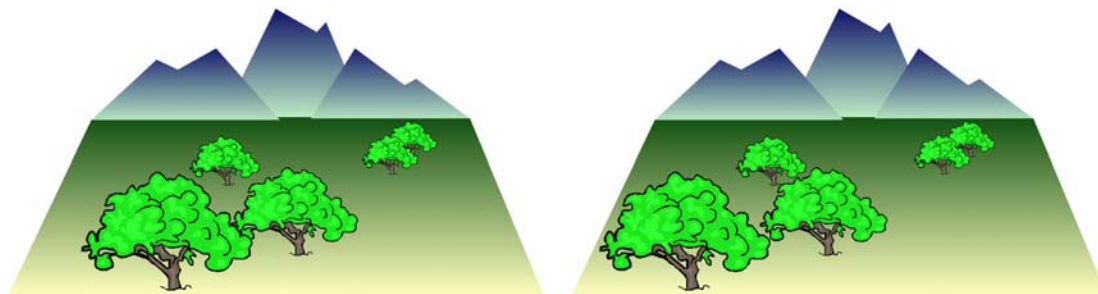
**Figure 1.** *The phenomena of retinal disparity*

The gist of accommodation is that looking at distant objects our crystalline lens become flat, while focusing on closer objects due to the contract of meridional fibres and the slack of suspensor ligaments, crystalline lens plump out (Figure 2). This functioning allows the image of the object to be projected on the macula lutea of the retina, the best phototropic visual acuity. To evaluate the distance, our brain's optical system probably uses the accommodation of the eyes too.



**Figure 2.** *The function of suspensor ligaments and ciliary muscle*

If one of the two objects with the same size is closer than the other, we see the closer one in a bigger viewing angle. Hence, if we move or the object moves, the same shift of the closer objects causes bigger alteration in the viewing angle, which means that the closer the objects are situated to us, the bigger their shift. This is the movement parallax, which helps conclude the distance between two objects. The movement parallax can be used in making three-dimensional graphics (Figure 3). We establish the pictures from the right and the left side by shifting the graphic's certain components to different distances, the closer ones to the beholder farther, the distant ones closer. In the case of same graphic components we can enhance the three-dimensional impression with perspective effects, for example if we reduce the far elements and move it uprightly.



**Figure 3.** *The graphics is made on the base of movement parallax principle*

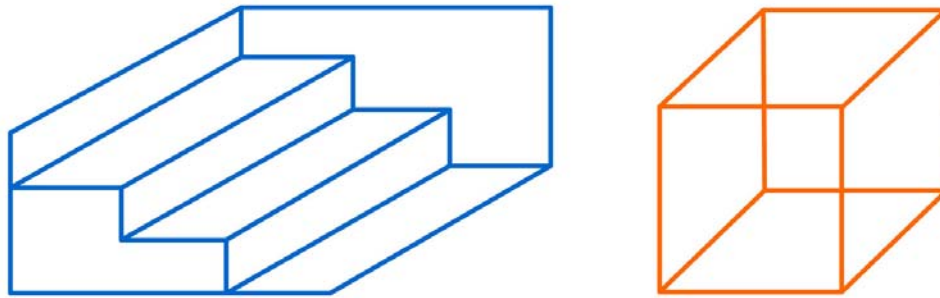
The praying mantis and the *Ranatra linearis* use movement parallax during predation (Figure 4), during the bait they make slow, vertical movements, this way they can determine precisely their capture location before they use their “raptorial foreleg”.



**Figure 4.** *Ranatra linearis* capturing a lesser water boatman

The perspective sight is evoked by visual elements, which transmit deep information to the optical center of our brain. These elements contribute to define a plane two-dimensional image in three-dimension. These kind of visual elements are the coherent lines, which are perceived by our optical system as distant parallel lines.

Covering (overlying) has information about space: the closer object to the beholder can fully or just partially cover the distant object, measurement changes: we see the distant object smaller, the relative altitude state: we see the higher objects distant, the abatement of detail profusion: the farther the objects are situated the less we see them detailed, shadings: images that can be interpreted as shadows suggest the three-dimensional and the perspective effects of colors: the effect of the atmosphere's light scatter makes the distant objects look more bluish than the closer ones. The aforementioned visual elements transmit deep information so vigorously towards our brain's visual center that we cannot exclude ourselves voluntarily from this effect. This demonstrates the “wire drawings”, which we can define as three-dimensional objects (Figure 5).



**Figure 5.** *Figures with spatial effect*

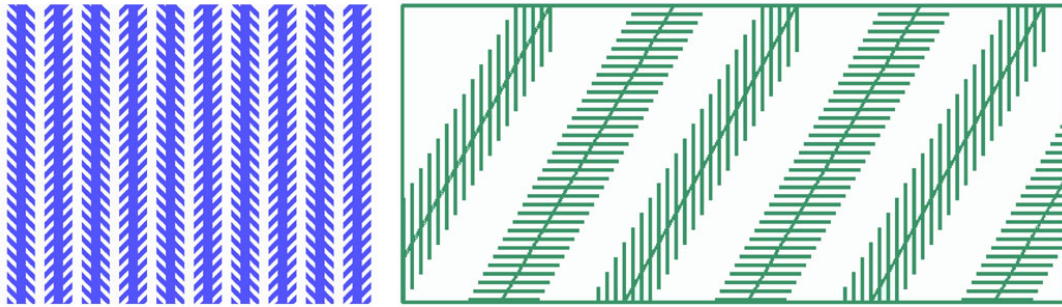


**Figure 6.** *A pair of stereo images can be made by reflection and recolor of a graphical object*

The two graphical objects are defined as truncated pyramid in our optical system (Figure 6). The image from the right side was made with the reflection of the left side image and with imitating realistic shadow conditions by toning. Example for this manipulation is the effort of our brain's visual center to develop two-dimensional perception ([www.freeweb.hu/kriskagy/3d1.htm](http://www.freeweb.hu/kriskagy/3d1.htm)).

Our optical system trait is that “endeavors” to create three-dimensional perception from the information which come from the eyes, and in this endeavor it doesn't shrink from crafting itself, which makes interpretable some of the visual illusions (Figure 9).

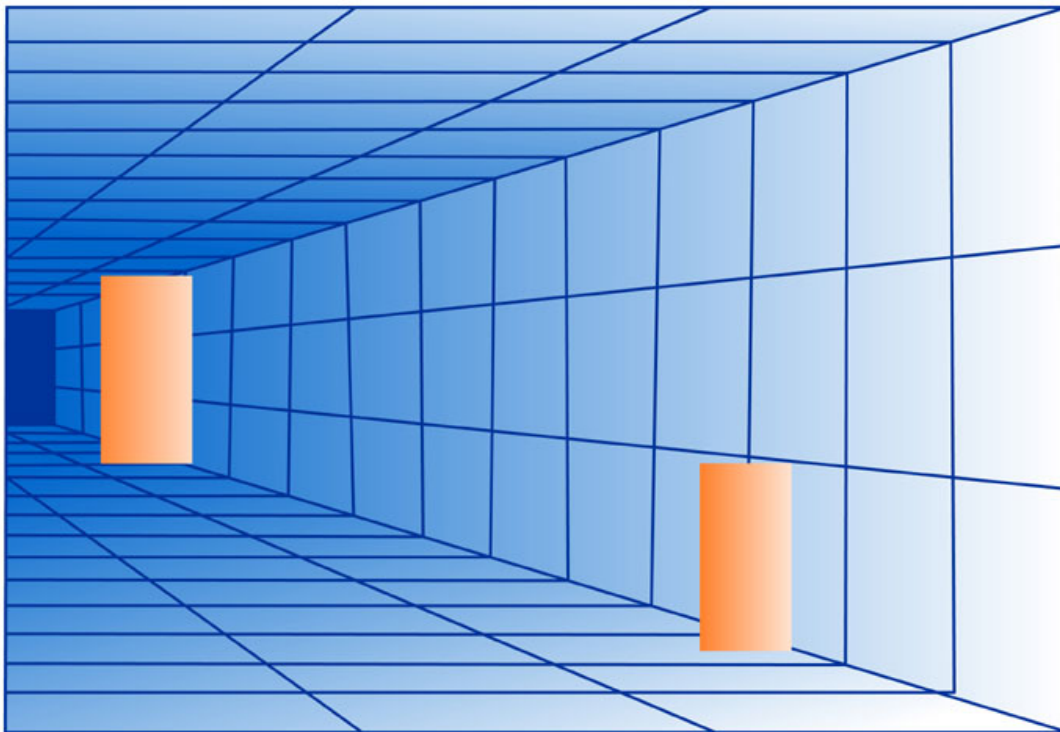
Perception of three-dimensional information is an important ability for every image viewer animal; hence it is understandable that in parallel with the development of the optical system, the evolution of the brain's visual center is a subordinate for the same purpose.



**Figure 7.** *Zöllner illusion*

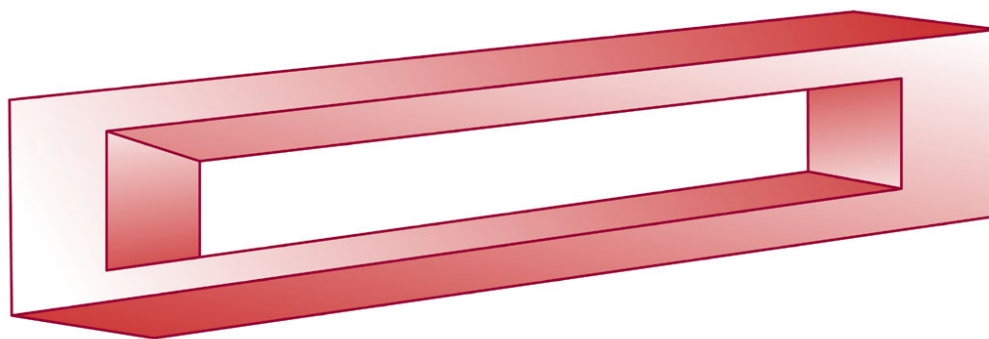
In an image with the same perspective elements, as above mentioned, long and distant lines should be coherent, short lines should get dense, according to our brains forced three-dimensional perception, which in pictures with long, parallel lines and with short lines, equally situated from each other induces disharmony, the appearance of the so-called Zöllner illusion (Figure 7) (Block and Yucker, 1992, Seckel 2005, 2007,).

In case of corridor-illusion (Figure 8) the image about the hallway induces a vigorously perspective effect on our brain's optical system, therefore the higher situated columns look bigger then the others, even though they all have the same size (Seckel 2007).



**Figure 8.** *Corridor-illusion*

Because of the corridor's perspective effect, our brain detects the higher situated columns as if they were distant, hence according to our visual center's position sensor the two columns can look the same on the image, more exactly the images of the columns projected on the retina can be the same, if in reality the higher situated column is bigger.



**Figure 9.** *The human brain tries to view in a perspective way even the figure unimaginable in space*

## Conclusion

The use of digital photography and computer help us to make three-dimensional pictures. We present in this paper the visual elements, which contribute to define a plane two-dimensional image in three-dimension: coherent lines, the covering, the measurement changes, the relative altitude state, the abatement of detail profusion, the shadings and the perspective effects of colors.

## Literature

- [1] Block J. R. and Yuker H. (1992), *Can you believe your eyes?* Psychology Press, p. 248
- [2] Ferwerda J. G. (2003), *The World of 3-D. A Practical Guide to Stereo Photography.* Reel 3-D Enterprises, p. 300
- [3] <http://www.freeweb.hu/conversion3d/index.html>
- [4] <http://www.mozaik.info.hu/mozaweb/Feny/p54.htm>
- [5] Kaufman P. L. and Alm A. (2003), *Adler's Physiology of the Eye.* Mosby, Incorporated, p. 904
- [6] Sárosi Ferenc (2003), Térhatású szemléltetés a biológia oktatásában. *A biológia tanítása – módszertani folyóirat XI/2*, 11–23
- [7] Seckel A. (2005), *Impossible Optical Illusions.* New York: Sterling Publications, Spring, p. 90
- [8] Seckel A. (2007), *The Great Book of Optical Illusions.* Firefly Book Ltd., p. 304
- [9] Snell R. S. and Lemp M. A. (1998), *Clinical Anatomy of the Eye.* Blackwell Science. p. 423

## Authors

**Noémi Szállassy**, Babeş-Bolyai University, Department of Psychology and Science Teaching Education, Cluj, Romania, e-mail: [szallassy@gmail.com](mailto:szallassy@gmail.com)

**Gánóczy Anita**, Karinthy General Community Centre, Homoktövis Environmental Didactic Centre, Budapest, Hungary, e-mail: [anita.ganoczy@gmail.com](mailto:anita.ganoczy@gmail.com)

**Kriska György**, Eötvös University, Biological Institute, Group for Methodology in Biology Teaching, Budapest, Hungary, e-mail: [kriska@ludens.elte.hu](mailto:kriska@ludens.elte.hu)

### Acknowledgement

We would like to thank to Aczél Fridrich Zsuzsanna and Helena-Maria Sabo for their kind help in translation.