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Non-extensive Distribution of Human Eye Photoreceptors

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Abstract

Spatial distribution of cone and rod photoreceptors in human eye retina, are studied by using non-extensive statistics. We show that photoreceptors' packing density obeys q-exponential and q-Gaussian distributions. Cones retinal distribution has higher non-extensivity in young subjects in comparison with old ones. Absolute value of q-parameter for spatial distribution of both types of photocells gets higher values along horizontal meridian. We also calculate Shannon's additive entropy and Tsallis' non-additive entropy for cone photocells distribution in retina, and compare their results. Information entropy, especially Tsallis entropy, is capable to discriminate between young and old subjects, properly. Our results confirm the ability of non-extensive statistics to unveil retinal eye problems caused by abnormal photoreceptors distribution.

Keywords: human eye, photoreceptor, Tsallis statistics, non-extensivity, entropy

1. Introduction

Human eye, as a complex organ, provides and adapts a great amount of visual information for us. Eye consists of three layers: outer, middle and inner [1, 2]. Cornea and sclera are the outer layers. The middle layer of the eye is composed of iris, ciliary body and choroid. Retina, as inner layer of the eye, is a complex and layered structure of neurons that transmits light to the brain [3, 4].

The retina is a light-sensitive layered structure with several layers of neurons interconnected by synapses at the back of the eye that covers about two third of its interior surface. Optics of the eye creates an image of the visual world on the retina. The retina and its corresponding visual field are divided into quadrants. In this scheme, the surface of the retina is subdivided by vertical and horizontal lines that intersect at the center of the fovea. The vertical line divides the retina

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