Color Perception in Patients with Ocular Diseases Leading to Low Vision

Almaliotis D.[1], Almpanidou S.[1], Karampatakis V.[1]

1. Laboratory of Experimental Ophthalmology, Aristotle University of Thessaloniki

ARISTOTLE UNIVERSITY OF THESSALONIKI

INTRODUCTION

Normal human color vision is trichromatic[1]; any color can be matched by the mixture of 3 primary colors. It depends on normal functioning and generation of signals in short wavelength (S), middle wavelength (M) and long wavelength (L) sensitive cones as well as on normal processing of these signals in the retina. The red /green (RG) channel uses L and M cone signals while the yellow/blue channel uses S cone signals[1] (**Figure.1**). The current review evaluates the potential role of color vision as an adjunctive indicator of disease progression in a wide spectrum of ocular diseases.

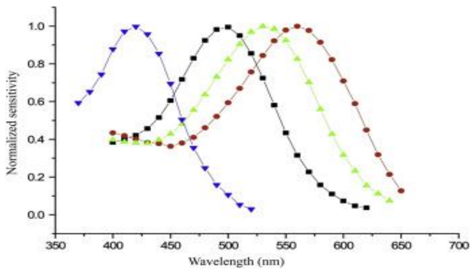

Figure.1:The spectral sensitivities of the 3 classes of cone photoreceptor (S-cones, blue inverted triangles; M-cones, green triangles; L-cones, red circles) and of the rods (black squares) plotted against wavelength in nm.[2]

METHODS

A filtered preliminary review was conducted using the PubMed search tool of the bibliography related to the decline and differences in color perception during the progression of ocular diseases.

RESULTS

The reduction in blue-yellow color has been described in cataract, age-macular degeneration (A.M.D.), diabetic retinopathy and glaucoma[1,2,3,4]. During cataract progression visual function is affected and the perception of color can be altered. Acquired red-green sensitivity deficiency has been detected in patients with A.M.D. , Stargardt's disease and Leber Herditary Optic Neuropathy. [1,2,3,4] **Table 1** demonstrates the type of color vision deficiency detected in several ocular pathologies according to Varriest classification, which is the most widely used for acquired color vision deficiency.[2]

Table 1: A summary of the Varriest classification of acquired color vision deficiency[2]

TYPE	SEVERITY	OCULAR DISORDERS
No defined axis	Trichromatic/Monochromatic	**Macular cysts, toxic amblyopia**
Type I **Red-Green**	Trichromatic/Dichromatic	**Choroidal atrophic processes** **Stargardt's disease** **Cone-Rod dystrophy**
Type II **Red-Green**	Trichromatic/Dichromatic	**Usher's syndrome,Optic Nerve Disease, Toxic amblyopia,Optic Atrophy, hiasmal Disorders, Peripheral Chorioretinal Degeneration, Rhegmatogenous Retinal Detachment, Central Serious Retinopathy, Chorioretinitis**
Type III **Blue-Yellow**	Trichromatic/Dichromatic	**Vascular Retinopathies (Diabetic, Hypertensive), Papilledema, Glaucoma, Dominant Optic Atropthy, Rod dystrophies-Retinitis Pigmentosa**

DISCUSSION

According to the literature the most common acquired color sensitivity deficiency is secondary to the increase in optical density of the lens observed with age. These lens opacities tends to absorb short-wavelentgh radiation including short wavelength visible light. However, since these changes occur gradually they are seldom noticed.[2]

In a systematic review of 15 studies was pointed out that most of the retinal diseases are associated with loss of color sensitivity with a tendency toward greater YB loss.[5] One possible explanation could be that S cones are less in the very central region of the retina accounting for an only small percentage(~5.7%) of the photoreceptors.[1] There is also indirect evidence that S cones are more vulnerable to pathologic processes such as diabetes, retinitis pigmentosa and glaucoma.[2] The specific loss of color sensitivity in the early stages of most ocular diseases could be attributed to the underlying choroidal hypoxia and subsequent reduced oxygen saturation of the retina which compromise the normal functioning of the highly metabolically active photoreceptors.[1]

CONCLUSION

The microenvironment changes in the retina may not be reflected by corresponding clinical signs. Hence, color thresholds could potentially serve as an adjunctive diagnostic tool for detecting alterations in visual function early in the course of some ocular diseases, before severe visual impairment is established.

Acknowledgment

This research has been co-financed by the European Union and Greek national funds through the Operational Program Competitiveness, Entrepreneurship and Innovation, under the call RESEARCH – CREATE – INNOVATE (project code:T1EDK-03742)

REFERENCES

1.Vemala R, Sivaprasad S, Barbur JL. Detection of early loss of color vision in age-related macular degeneration – with emphasis on drusen and reticular pseudodrusen. Invest Ophthalmol Vis Sci. 2017;58:BIO247–BIO254

2.Simunovic MP, Franzo Bchir. Acquired color vision deficiency. Survey of Opthalmology 61 (2016) 132-155

3.Wolff BE et al. Color vision and neuroretial function in diabetes. Doc Opthalmol (205)130:131-139

4.Anh-Tuan V et al Acquired color vision deficiency in Vietnamese patients with primary open angle glaucoma. Eye SEA 2017;12(2):29-35

5.Neelam K, Nolan J, Chakravarthy U, Beatty S. Psychophysical function in age-related maculopathy. Surv Ophthalmol. 2009; 54:167–210.

European Union European Regional Development Fund

HELLENIC REPUBLIC MINISTRY OF ECONOMY & DEVELOPMENT SPECIAL SECRETARY FOR ERDF & CF MANAGING AUTHORITY OF EPAnEK

EPAnEK 2014-2020 OPERATIONAL PROGRAMME COMPETITIVENESS ENTREPRENEURSHIP INNOVATION

ΕΣΠΑ 2014-2020 Partnership Agreement 2014 - 2020

Co-financed by Greece and the European Union