# Design and validation of a novel color test to assess patients with visual impairment

Karampatakis V.[1], Almaliotis D. [1], Karamitopoulos L. [1], Kalliris G. [1], Almpanidou S. [1]
1.Laboratory of Experimental Opthalmology, Aristotle University of Thessaloniki, Greece

## Introduction

In a variety of ocular diseases one of the earliest signs of dysfunction in visual processing is impaired color vision. Cone cells are concentrated in the fovea and as these cells degenerate or the perception of visual sign is disrupted due to other pathologies, the ability of patients to distinguish colors is affected[1]. Hence, color vision testing is necessary for evaluation of the progression of various ocular diseases[1]. The aim of this study was to determine whether a novel color vision test, applicable on smartphones, can detect color vision loss. We also evaluated the agreement of results between this test and the Ishihara test (24 plate).

## Materials & Methods

A total of 124 participants (19 normal sighted and 95 visually impaired) were enrolled and 184 eyes were examined [34 normal and 150 visually impaired (Fig.1)]. 21participants (33 affected eyes) were examined twice within a 3 week period in order to establish test-retest reliability. Subjects completed testing with each eye separately at up to thirty standardized color targets, with decreasing levels of intensity on RGB color value. The best corrected visual acuity (BCVA) was detected and the individuals were examined with the Ishihara 24 color plates test. Correlation between scores in red, green and blue intensity scaling and BCVA was evaluated. We also compared the performance of the participants in this novel test with that in the Ishihara test.

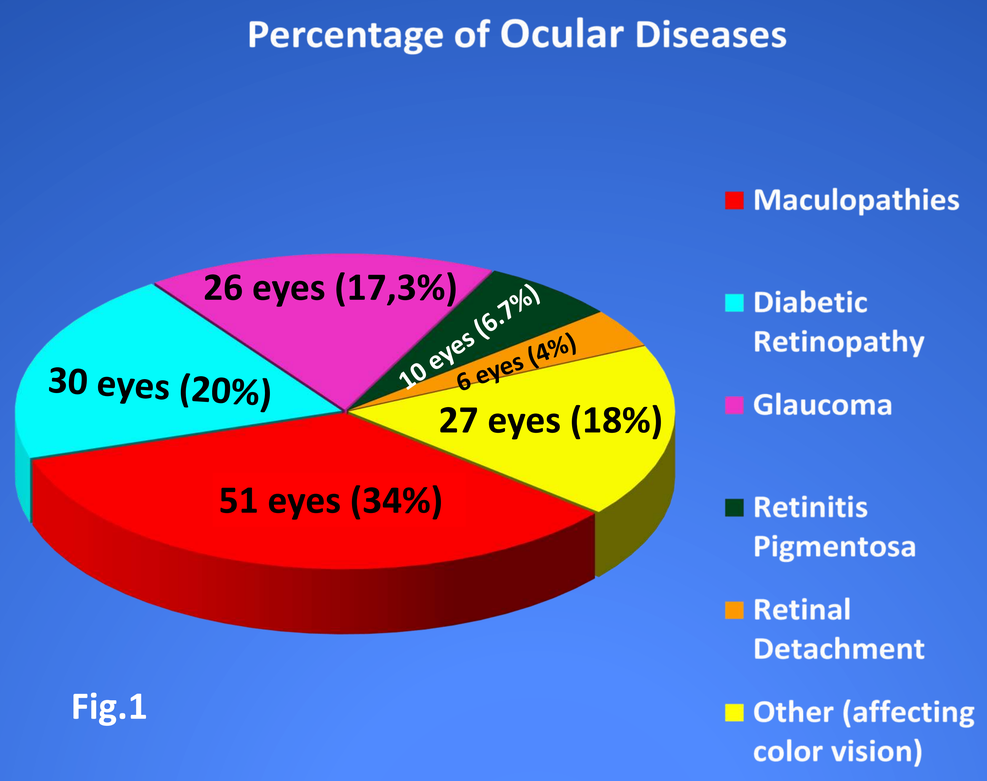


Fig.1

## Results

Test-retest reliability coefficients (Intraclass Correlation with 95% confidence intervals) were high for red [ICC=0.990 (0.980-0.995), green [ICC=0.980 (0.959-0.990) and blue [ICC=0.981 (0.962-0.991) color, suggesting repeatability and consistency of the measurement. Mann-Whitney test indicated that scores of visually impaired subjects in red, green, and blue were lower ($p<0.001$) as compared with those of normal eyes (Fig.2) and the severity of vision loss was correlated with the scores in each color ($p<0.001$). Subjects with absolute inability to read Ishihara plates provided lower scores ($p<0.001$) in each color.

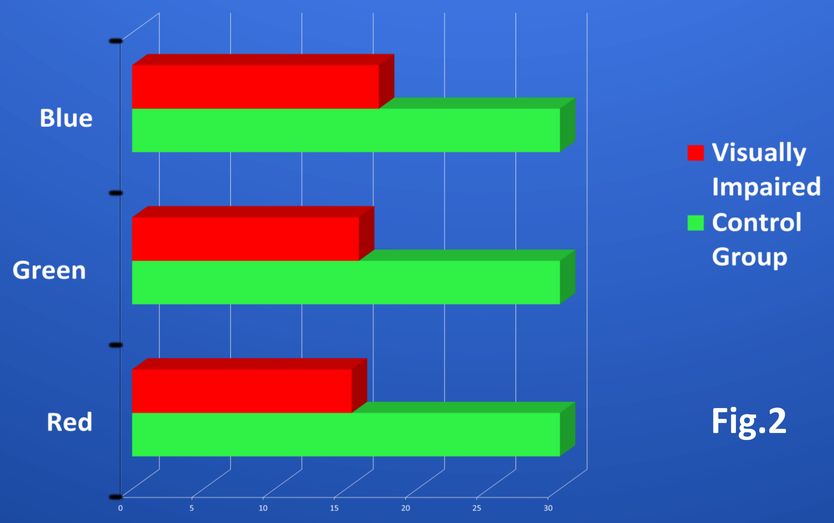


Fig.2

## Discussion

In this study, the reliability and the ability of a novel color vision test to discriminate normal from impaired color vision, was examined. The most widely used color vision test in the everyday practice is the Ishihara test, though it is not very sensitive in all color deficiencies and it has to be combined with another test e.g. the HRR test for a more comprehensive color examination[2]. Patients, who cannot read Ishihara plates had detectable, though lower, scores in our test, indicating that this test is able to reveal color deficiencies beyond the limits of Ishihara. This smartphone application may be quite promising as an alternative choice for color vision assessment for the clinicians, providing quick and accurate testing of color vision[4]. Also for the patients, may serve as a self-monitoring tool for earlier detection of changes indicative of a deterioration of the underlying disease.

## Conclusion

It is interesting that this novel color test has reliability but also the ability to detect color deficiencies that he Ishihara test fails to detect. More disease specific color deficiency detection, by its use, is under investigation that is in progress.

## References

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