Colour vision in type 1 diabetes

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Abstract:

Purpose
The purpose of this study was to investigate how type 1 diabetes affects color vision, even among individuals without visible ocular complications. Previous studies have suggested that diabetes may accelerates degenerative changes in the eye, negatively impacting color perception. Light may be lost before being absorbed by the retinal cones. Early disruption of blood-retina barrier, which occurs at the initial stages of diabetes, may play a significant role in decreasing permeability. Serum protein leakage and other blood components entering the retina and posterior vitreous may contribute to light loss through absorption and/or scattering. Additionally, the increased concentration of proteins in the optical media, including the lens, might enhance light scattering, particularly blue light.

Method
To evaluate color discrimination, participants underwent the Farnsworth-Munsell 100-Hue test and anomaloscope. The study included two groups: 8 individuals with type 1 diabetes and 8 healthy subjects within a similar age range. All participants in the diabetic group had been diagnosed with diabetes for more than 4 years, with a mean disease duration of 14.38 ± 7.82 years. Those with previously diagnosed color vision deficiencies were excluded, and none of the participants in the diabetic group exhibited any ocular complications. Before testing, each participant underwent a preliminary interview and visual acuity test.

Results
The results supported the hypothesis that Type 1 diabetes negatively impacts color vision. Diabetic participants made significantly more errors on the Farnsworth-Munsell 100-Hue test, with an average Total Error Score (TES) of 55.63 ± 9.21 compared to 5.25 ± 7.32 in the control group. Additionally, diabetic participants required a significantly longer total time to complete the test. The average total test completion time for diabetic participants was 586.63 ± 176.77 seconds, while for control participants, it was 479.38 ± 59.97 seconds. Using the anomaloscope the anomaly quotient (AQ) on the blue-green axis (Moreland Equation) was near statistical significance ($p=0.052$), indicating potential changes in color perception in the diabetic group. In contrast, no significant differences were observed in the Rayleigh Equation (red-green axis), with all results remaining within the normal range. These findings align with prior research, although the number of subjects was relatively small. Future research could benefit from expanding the study group and incorporating a greater diversity of participants in terms of gender, age, and disease duration.

Conclusion

As a result of the conducted research, it was demonstrated that type 1 diabetes, even in the absence of visible complications in the visual system, affects color discrimination abilities in patients. These results are particularly relevant for vision care specialists, as regular color vision assessments could serve as an early indicator of visual impairments in people with type 1 diabetes, enabling early detection of potential diabetic retinopathy. Consequently, color vision tests should be considered a routine component of optometric examinations for diabetic patients.

References (selected, among others):

Daley, M., Watzke, R., & Riddle, M. (1987). *Early loss of blue-sensitive color vision in patients with type I diabetes*. Diabetes Care, 777–781.

Hardy, K., Lipton, J., Scase, M., Foster, D., & Scarpello, J. (1992). *Detection of colour vision abnormalities in uncomplicated type 1 diabetic patients with angiographically normal retinas*. British Journal of Ophthalmology, 461–464.

Roy, M. S., Gunkel, R. D., & Podgor, M. J. (1986). *Color vision defects in early diabetic retinopathy*. Archives of Ophthalmology, 225–228.

Verriest, G. (1963). *Further studies on acquired deficiency of color discrimination*. Journal of the Optical Society of America, 185–195.

Schwartz, S. H. (2017). *Visual perception: A clinical orientation*. New York: McGraw-Hill Education.

Farnsworth, D. (1957). *The Farnsworth-Munsell 100-Hue Test for the examination of color discrimination*. Munsell Color Company.

Kinnear, P., & Sahraie, A. (2002). *New Farnsworth–Munsell 100-Hue test norms of normal observers*. British Journal of Ophthalmology, 1408–1411.

Pease, P. L. (2006). *Color vision*. In W. J. Benjamin (Ed.), Borish's Clinical Refraction (2nd ed., pp. 289–355). Butterworth-Heinemann.

Sayin, N., Kara, N., & Pekel, G. (2015). *Ocular complications of diabetes mellitus*. World Journal of Diabetes, 92–108.

Wosik, J., Pniewski, J., & Ambroziak, A. (2014). *The Farnsworth-Munsell 100-Hue test: Scientific basis and clinical application*. Okulistyka, 48–57.