# Investigating the impact of colour vision deficiencies on everyday task performance

*Jing-Yi Tham ( 210524420, MBBS, J.Tham3@newcastle.edu.my )
Supervised by: Anya Hurlbert, Ilgin Cebioglu

Newcastle University

## 1. Introduction

The ability to see colours is achieved by the presence of three types of photoreceptors, known as cones, in the retina. (1) The photopigments in each cone type are sensitive to a different bell-shaped spectrum of light wavelengths, peaking at 420nm, 530nm and 560nm respectively. (1) Different excitation ratios of the three cone types mediate different colour percepts. (1)

Colour vision deficiencies (CVD), more commonly known as colour blindness, occur when there are either anomalies or absence of photopigments for at least one cone types. (1) Protan- relates to long wavelength, deutan- to middle wavelength, and tritan- to short wavelength. (1)

In this study, we aim to design a computerised test to measure the impact of CVD on object searching, and to determine the importance of colour in identifying individuals or objects based on verbal descriptions.

## 2. Methods

6 real-life images and 2 AI-generated images are used.

Target and reference objects selected based on similarity of features.

Prompts to find the target objects are created, which describe the age, gender, colours and types of clothings, and other defining features.

Colours of the target objects are modified to lie on the same confusion lines (Figure 4) as the reference objects, for both protanopia and deuteranopia, so that the two objects look similar in colour to protanopes and deuteranopes respectively.

Participants are shown a prompt on a computer for 10 seconds, and they are required to select the object that fits the prompt.

## 2.1 Methods

Figures 1,2 and 3 demonstrate an example. The man with grey shirt and a black vest in the middle (red circle) is the target, and the man behind with a blue shirt (yellow circle) is the reference. The simulated image shows that both shirts will look blue to protanopes.

Figure 1: Original image

Figure 2: Modified image for protanopia

Figure 3: Simulated image for protanopia

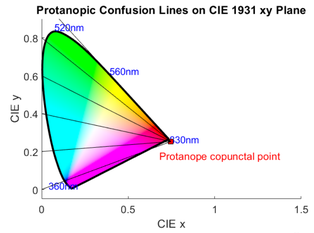


Figure 4: Protanopic confusion lines

## 3. Results

A pilot run was carried out with 3 participants with normal colour vision. The computerised test consists of 6 original and modified images, and 6 simulated images. The simulated images are included to represent the results for CVD.

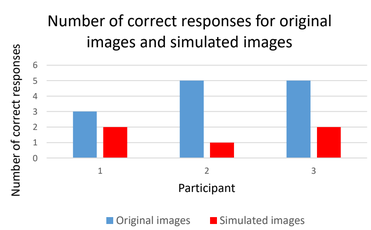


Figure 5: Comparison for the number of correct responses

Figure 5 compares the number of correct responses between the two set of images. Overall, participants performed worse for images that are edited to simulate the absence of long wavelength cones. However, actual CVD participants will need to be involved to verify the accuracy of these results.

## 3.1 Results

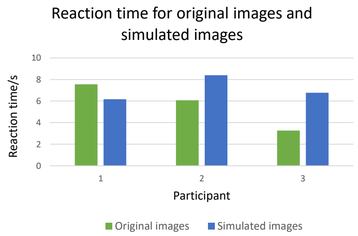


Figure 6: Comparison for reaction time

Figure 6 compares the reaction time between the two sets of images. The results show an inconsistent trend, where CVD-simulated images do not necessarily require longer time to respond, regardless of the accuracy.

Based on the results, CVD-simulated images present more difficulty in differentiating colours that lie on the same confusion lines, therefore impacting the ability to recognise objects based on colours.

However, the data above are collected from a trial run with a limited number of participants, so the results are insufficient to draw a reliable conclusion. The results above should only be used as a reference for future studies, to observe and evaluate the overall trend of the impact of CVD on object searching.

## 4. Conclusion

To produce more accurate and reliable results, a larger number of participants, with a mixture of CVD and normal colour vision, should be recruited in future studies. Further improvement to the test also needs to be made, to minimize the influence of other external factors on participants' responses.

Other research topics in this field include differences in colour naming for colours of different hues and saturation, impact of natural daylight and artificial lighting on the appearance of food items, etc. These projects also contribute in assessing the impact of CVD on everyday task performance.

## References

1. Westland, S. (2002) 'Functional colour vision', in *Signals and Perception: The Fundamentals of Human Sensation*. Basingstoke: Palgrave/Open University, pp. 133–146.