New approach to colour vision assessment

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Credit: Ivan Babydov from Pexels

Many people with congenital deficiency who wish to become pilots, air traffic controllers, train drivers or electricians may be able to work safely in such professions due to a test developed by researchers at City, University of London.

Currently many people with such colour vision issues are stopped from doing so, even when they can carry out the colour-related, visually demanding, occupational tasks as effectively as people with normal colour vision.

But the new Colour Assessment and Diagnosis (CAD) test - and accompanying new Colour Grading System - developed by researchers at City, University of London can help solve these problems and ensure safety in such professions by accurately assessing the severity of colour vision loss.

In addition, the test will also solve current issues with conventional screening, as currently some people with severe loss of colour vision pass the tests and are therefore potentially unsafe.

Using the CAD test, a single colour assessment is now needed to place the applicant into one of six colour vision (CV) categories which range from 'supernormal' (CV0 - a category suitable for extremely demanding colour-related tasks) to 'severe colour deficiency' (CV5 - when red/green colour vision is either absent or extremely weak).

Existing occupational tests, such as the widely used Ishihara (IH) and Holmes-Wright (HW) tests, currently pass some people with colour deficiencies who should fail, while also failing people with normal colour vision who should pass, resulting in unfair discrimination.

The main outcome of using the more accurate CAD test is that, in many professions, three times more colour deficient people pass, and, more importantly, those who pass are three times less severe. Safety is therefore improved and unfair discrimination minimised, when comparison is made to current practices.

Equally important, colour vision standards can now be enforced

internationally using a grading system which ensures adequate colour vision requirements for each profession. The six grades available rely on a single CAD assessment and the appropriate category is assigned to a given occupation based on evidence derived from detailed, visual task analysis and the statistical outcomes of current practices within that occupation.

In addition to congenital deficiency, acquired loss of colour vision in people with diseases of the eye is also detected and graded according to the measured severity of loss. Recent findings from studies carried out by City researchers show that over 70 per cent of people with diabetes show significant losses of colour vision, even before any physical damage is seen in the eye due to the disease. The paper is published in British Medical Bulletin.

To investigate the effectiveness of existing tests versus the CAD test, the researchers examined colour assessment outcomes and quantified severity of colour vision loss in 1,363 subjects.

The severity of colour vision loss was measured in each subject (using the CAD test) and statistical, pass/fail outcomes established for each of the most commonly used, conventional colour assessment tests and protocols. The results were unexpected and turned out to be extremely important.

For example, using the current industry standard, which relies on the number of errors people make on the most commonly used IH test (with two or fewer errors as a pass), only 0.3 per cent of people with normal vision fail, but almost 8 per cent of people with colour deficiency pass the test. More importantly, those that pass can exhibit severe loss of colour vision requiring 14 times greater red/green colour signal strength to just see red/green colours, when compared to people with normal colour vision. As a result, many of those that pass may not be safe.

An alternative approach that has been used in some occupations is to pass only those with no errors on the more thorough 38 plates IH test. This protocol has the advantage of detecting almost all people with colour deficiency, but as many as 19 per cent of people with normal colour vision also fail the test. A secondary test (usually the HW lantern) is then employed. The HW test passes all normal subjects that fail IH, together with 22 per cent of people with colour deficiency. The latter are therefore also classed as having normal colour vision.

However, the introduction of the CAD test and the new colour grading system solves these problems. The new approach has been adopted within aviation for cabin flight crew, air traffic controllers and London underground drivers, leading, in some occupations, to as many as one third of applicants with congenital colour deficiency working safely in their chosen field.

Professor John Barbur (Division of Optometry and Visual Science at City, University of London), inventor of the CAD test and lead author of the study, said:

"This paper represents a milestone in research in colour assessment with significant repercussions affecting occupations and healthcare. An important realisation that emerged from our studies is that that normal colour vision is not required in all visually demanding professions and that severity of colour vision loss can be quantified accurately.

"In contrast to the many current tests and protocols which produce inconsistent results, the new system designed to grade severity of colour vision loss can be enforced, leading to rigorous, consistent and justified standards. In addition to improved safety, the new approach enables many more colour deficient people to pass simply because current tests and protocols fail some colour deficient people who can perform the safety-critical, colour-related tasks as well as people with normal colour

vision.

"In particular, we found that when the CAD test and the new grading system are compared to the most commonly used, industry standard protocol (based on the IH 24 plates test with two or fewer errors as a pass), three times more colour deficient people pass, but most importantly, those who pass are three times less severely affected.

"The new test and grading system are being currently evaluated by the three defence services, the electrical contractors industry, the police authorities and European Aviation and Space Agency as a replacement for the battery of tests and protocols that are currently in use. The significant benefits of this approach are becoming more apparent and it is now just a matter of time before the new system of colour assessment is adopted internationally."

Provided by City University London