New approach to colour vision assessment
25 May 2017, by George Wigmore

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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 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