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HOW TO DO IT

PC-based colour vision tests

Occupational colour vision testing has traditionally been conducted using pseudoisochromatic plates, such as Ishihara, as the initial test with secondary tests such as lanterns for those who fail. Lantern tests can produce inconsistent results and are increasingly obsolete [1], and several PC-based tests have been developed to provide a more accurate and defensible assessment. Several such tests are commercially available in the UK including the City University Colour Assessment and Diagnosis (CAD), the Cambridge Colour Test (CCT), the Waggoner Color Vision Test (CCVT) and the Rabin Cone Contrast Sensitivity Test (CCST). All share the ability to accurately identify colour vision deficiency and diagnose class of deficiency (e.g. protan, deutan or tritan), as well as quantify the severity of the colour vision loss, and can be reliably used to separate candidates with normal trichromatic vision from those with any form of deficiency. While all the above tests do a similar job, the CAD test is the best validated and most widely available in the UK and will therefore be used as the reference test in this article.

The CAD test can be used both as an initial screening test and for a diagnostic colour vision assessment. The CAD-Pro test incorporates the new CAD-Screener which allows rapid assessment of normal red/green (RG) and yellow/blue (YB) colour vision. This takes ~120 s to complete and identifies accurately those with congenital or/and acquired colour deficiency. Virtually all normal trichromats pass. It is also expected that a small percentage (~4%) of the least affected deutans with close to normal RG chromatic sensitivity will also pass. No protan subjects pass the CAD-Screener. The 'definitive' CAD option provides full RG (~9 min) and YB (3 min) assessments with automatic classification of the applicant's class of colour vision and severity of loss. All applicants who fail the CAD-Screener test would be required to take a full CAD test to diagnose their type of colour vision deficiency and to quantify the severity of loss. This compares favourably with screening with Ishihara plates which will identify all those with RG congenital deficiency, but will also fail 19% of normal trichromats. In the case of the full Ishihara test, ~24.5% of male applicants would require a secondary test [2].

The test itself is straightforward for both the operator and the subject. It is run from a laptop and displayed on a second, fully calibrated screen, viewed by the subject from ~1.4 m. The subject is provided with a keypad on which are four buttons and, following a short demonstration test lasting ~1 min, starts the test. The test screen displays a pixelated grey background in which each square check varies randomly in luminance to isolate the use of colour signals (Figure 1). The subject must identify the direction of travel of coloured block by selecting the appropriate keypad button (top right, top left, bottom right, bottom left). The test output provides a summary of the results for both the RG and YB axes, expressed in CAD units (Figure 2). These units are statistically derived, with one CAD unit describing the average signal threshold for a young, healthy, normal trichromat, and the pass mark can be set at an appropriate CAD threshold for the required colour vision task. For example, the Civil Aviation Authority has set the minimum colour vision requirements for flight crew as 6 CAD units [3], whereas the Maritime and Coastguard Agency has determined that the visual demands of bridge watchkeeping require better colour vision and have therefore set their pass at 2.35 CAD units.

The benefit of screen-based tests such as the CAD are that, unlike lantern tests, they are repeatable, reliable and cannot be learnt. They can also diagnose and quantify the level of colour vision deficiency, which is important in occupations where a mild colour deficiency could be classed as safe, allowing more equitable and inclusive decisions on fitness for certain duties. These tests are also user-friendly for both the examiner and the subject, and the diagnosis is carried out automatically.

Their main disadvantages are the initial purchase cost and the lack of portability. These disadvantages may be partly resolved soon; City University is developing a web-based version of the CAD-Screener which is expected to be launched in April 2019. The CAD-Screener runs on sRGB displays and is likely to be free to download and use.

The CAD-Pro Test costs £6875 for the hardware and software package and can be purchased from City Occupational: http://www.city-occupational.co.uk/products/.

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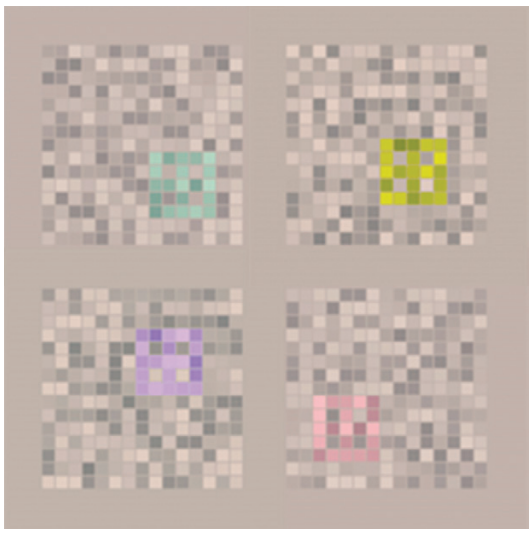

Figure 1. The CAD test screen showing coloured blocks moving through a flickering grey field. Images used by kind permission of City Occupational Ltd.

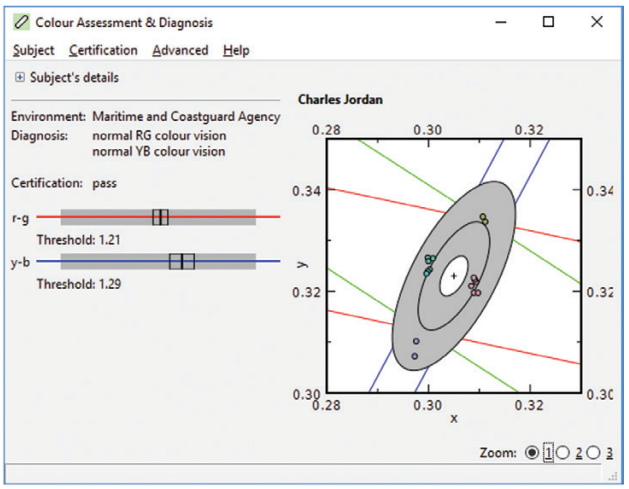

Figure 2. CAD output window showing the applicants red/green and blue/yellow thresholds. Images used by kind permission of City Occupational Ltd.

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