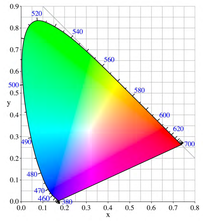


Preliminary Validation of a Computerized Color Vision Test

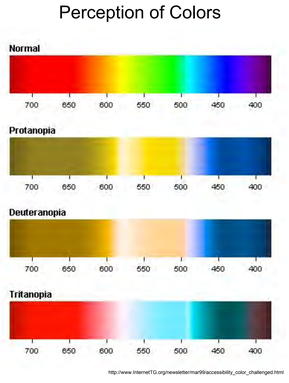
CDR David Picken, MD; CDR William Mann, MD, MPH; CAPT Matthew Rings, MD

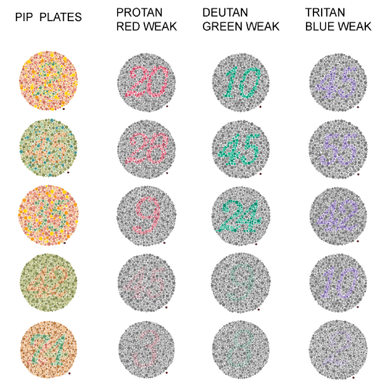
Naval Aerospace Medical Institute, Pensacola, FL

Introduction

The Naval Aerospace Medicine Institute (NAMI) has noted up to 3% of aviation applicants are color deficient. NAMI has developed a Computerized Color Vision Test (CCVT) that detects, classifies and quantifies the degree of color vision deficiencies.

Currently naval aviation applicants are screened with the Ishihara Pseudoisochromatic plates (PIP) and the Farnsworth Lantern (FALANT). These tests are subject to operator errors (lighting, timing, plate fading) and do not delineate the type and degree of color deficiency. The CCVT mitigates the shortcomings of currently used tests.

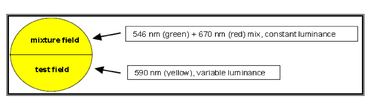




Methods

As part of a clinical process improvement aviation applicants were tested on the Ishihara PIP, the FALANT, the Nagel Anomaloscope, and the CCVT. Applicants were between the ages of 18-29 and four were female. Aviation qualification was based only on PIP or FALANT scores.

The FALANT was administered with an OPTEC-900 at 8 feet. The Ishihara PIP was administered with 6280K fluorescent lighting, and passing was a minimum score of 12/14 correct. The Nagel Anomaloscope was set at a luminance of 17, a starting point of 46.5, and a normal range of ±6.



Nagel Anomaloscope View

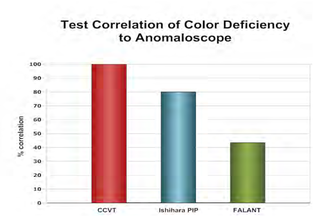
The CCVT has 4 sections which consist of confusion colors and decreasing steps of desaturated colors similar to the American Optical HRR. The test plates were developed using Adobe Illustrator and the monitor colors were validated with a colorimeter.

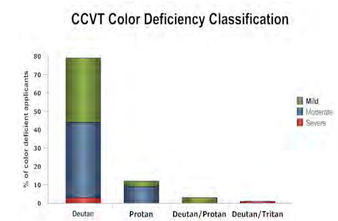
The CCVT is administered in a dim room or on a matte screen to minimize glare. The test plates are given in succession with 2 seconds viewing time for each plate. After viewing the test plate, the applicant selects an answer from 9 choices. The test is self-administered and automatically scored.

The Chi-squared test was used for statistical analysis.

The protocol was approved by the NMOTC Scientific and Ethical Review Committee.

Results

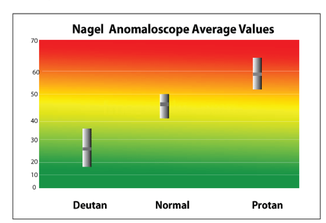




Applicants with normal color vision per the CCVT passed both the PIP and FALANT, and had normal color vision on the Nagel Anomaloscope.

The CCVT correctly identified every color deficient applicant (n=35), as confirmed by the Nagel Anomaloscope ($p < 0.001$).

	Sensitivity
Anomaloscope	1.00
Ishihara	0.80
FALANT	0.52
CCVT	1.00



57% of color deficient applicants identified by the CCVT, and confirmed by the Anomaloscope, passed the current naval aviation standard. Of those identified as moderately color deficient by the CCVT, 37% met standards with the FALANT.

Only one mild color deficient applicant failed to meet standards by either the PIP or the FALANT.

Discussion

Preliminary findings have shown the CCVT correctly identified all color deficient applicants as confirmed by the Nagel Anomaloscope and did not misclassify any color normal applicants.

The Ishihara PIP has, under ideal conditions, a sensitivity of 98.7% (Birch, 1997). Our Ishihara sensitivity was lower possibly due to non-ideal testing conditions. The lower color deficiency prevalence in naval aviation applicants is presumably because of pre-screening examinations. However, a higher number of color deficient applicants than expected are passing the pre-screening.

The FALANT test was developed as an occupational suitability test for ship drivers during World War II and was designed to pass 30% of color deficient individuals (Laxar, 1998). The current utility of the FALANT as an aviation color vision screening test has been questioned (Cole & Maddocks, 2008). Our preliminary findings suggest that over 50% of color deficient applicants are able to pass the FALANT.

With the increasing prevalence of modern multicolor aviation instrumentation in the air and on the ground, legacy screening exams may no longer be adequate. Some authors feel a reliable and reproducible color vision test is needed in the U.S. military that does not require operator training (Monlux, Finne, & Stephens, 2010). Our findings suggest the CCVT will provide accurate and standardized color vision screening. Formal studies of the CCVT may be warranted.

Conclusions

- Based on preliminary findings the CCVT has increased sensitivity and specificity compared to the Ishihara PIP and FALANT, and is comparable to the Nagel Anomaloscope.
- The design of the CCVT reduces administration errors.
- Current color vision screening tests fail to identify all color deficient applicants.
- The CCVT appears to be a reliable, sensitive, and specific test for screening color vision in aviation applicants.

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Disclosure

We have no financial relationships and will not discuss off-label use and/or investigational use in our presentation.