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Original Article

Development of computerized color vision testing as a replacement for Martin Lantern

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ABSTRACT

Background: Development and standardization of computerized color vision testing as a replacement for Martin Lantern test. Non-randomized comparative trial.

Methods: All candidates of SSB, Allahabad, reporting for SMB underwent color vision testing at the eye dept by computerized eye test and currently available tests.

Results: All candidates were subjected to Ishihara chart testing and those found to be CP III were subjected to the confirmatory test on Martin Lantern and the Software. Candidates requiring CP I standards for eligibility were tested on the same on Martin Lantern and on the new software method. On comparison between the Standard Martin Lantern and the Software, the results were consistent and comparable with 82 patients testing CP I on the Martin Lantern and 81 on the software. Of the CP III patients, 253 tested positive on the Standard lantern test as compared to 251 on the software and of the CP IV group, 147 tested positive on the Standard lantern and 149 by the software method.

Conclusion: It was found that the software replicated the existing Martin Lantern accurately and consistently. The Martin Lantern Software can be used as a replacement for existing old Lanterns which are not in production since the early 20th century.

Introduction

Color discrimination is defined as the ability to differentiate between shades of a color or the difference between two or more colors. The factors that influence color discrimination have been described thoroughly (e.g., Kaufman, 1974; Schiff, 1980; Sekuler & Blake, 1990).

The human retina is made up of receptors called rods and cones. When only the rods, densest outside the central retina or macular area, are functioning, colors are not visibly perceptible. Cones, densest in the central retina, provide the perception of color. Humans with normal color vision are traditionally regarded as having three cone types, supporting trichromacy, the ability to match colors with three primaries.

Color vision testing in the armed forces has been based on use of the Martin Lantern and the Ishihara charts. The Martin Lantern (Fig. 1) is available at only limited centers and is an out of production model last produced in the 1940's.

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Fig. 1 – Martin Lantern & Computerized Martin Lantern.

Color vision standards in the armed forces

- CP I – Evaluated after testing on the Martin Lantern, at a distance of 6 m (20 ft)
- CP II – Evaluated on Ishihara charts
- CP III – Evaluated on Ishihara charts, confirmatory testing on Martin Lantern at 1.5 m
- CP IV – Evaluated on Ishihara charts, confirmatory test on Martin Lantern

This project was hence started to prepare a computerized alternative to the Martin Lantern which could be used on a standalone Personal Computer (PC) just like a Martin Lantern, leading to standardization of testing procedures across all eye centers in the army.

Color vision testing has been used over the ages and has seen a gradual improvement in methods available. One of the earliest methods was to ask a person to compare color of everyday objects with that of a normal person. Dalton in 1798 gave a detailed description of his own perceptions and that of his own brother and of 20 other persons.[1] Seebeck[2] in 1837 used a number of test samples and asked the observer to choose and match the same with samples. Variations of this method were developed by various researchers, namely, Holmgren[3] in 1877, who used wool skeins, Edridge Green[4] in 1920 using colored beads. Pseudoisochromatic plates were introduced by Stilling[5] in 1873. Lantern tests were introduced by Williams[6] in 1903. Early designs were often used for railway employees. Gradually, lanterns replaced the various wool tests. In a notable rearguard action, Abney[7] (1895) in his evidence to the Departmental Committee on Sight Tests, resisted moves to introduce lantern tests, preferring his laboratory spectral methods.

Lantern tests involve the naming of small lights or "point sources", usually in a dark room. Lanterns have seldom included blue stimuli, so tritan effects or defects are not likely to be considered. A lantern test is usually more difficult in a bright room. Observing in complete darkness may give the best chance of success. However, there has been evidence that subjects with defective color vision may have poorer recognition of colors in a dark environment hence Holmes and Wright[8] permitted the use of their Aviation lantern "in moderate room lighting if desired". A number of electric lanterns were also developed, notably by Martin[9,10] (1939, 1943) and by Sloan[11] (1944).

Ishihara tests, based on color plates, are a quick way of detecting color vision abnormalities, but are limited in their ability to classify abnormalities. Tests such as the Farnsworth Munsell 100 Hue test are a better method of distinction between various types of defects. However, these techniques are prone to error if ambient lighting is not standardized, and the color pigments used in the tests tend to degrade with exposure to light or contact with sweaty fingers.

Color vision deficiency is a term used to describe a number of different problems people have with color vision. Their incidences are approximately 8% among Caucasian males (Pokorny, Smith, Verriest and Pinckers 1979; Sharpe, Stockman, Jägle and Nathans 1999). These problems may range from a slight difficulty in differentiating between different shades of a color to not being able to identify any color. Most people with poor color vision can't distinguish between certain shades of red and green. Less commonly, people with poor color vision cannot distinguish between shades of blue and yellow. Poor color vision is an inherited condition in most cases. However, eye diseases and the effects of some medications also can cause color deficiency. Men are more likely to be born with poor color vision. Often, a person who is red–green deficient isn't completely insensitive to both colors. Defects can be mild, moderate or severe, depending on the amount of light-sensitive substances missing from the cones. Someone with red–green deficiency may not be able to differentiate the colors of a rainbow or recognize a rose-colored sky at sunrise or sunset.

Interestingly, many people with red–green deficiency are not aware of their problem. Their "green" may be what normal-sighted people call "yellow", but because they've always heard leaves called green, they interpret what they see as "green".

There have been a number of attempts to develop methods of color testing based on PC based software. A Toufeeq[12] in 2004 has described an inexpensive PC based system for detection of color defects. Miyahara et al[13] developed a computerized, automated system to diagnose red green color defects using a CRT screen.

However, there have been no attempts at adaptation of existing tests into computer based software. All the PC based tests described have tried newer methods of testing. We have therefore tried to adapt the existing Martin Lantern test into a software based form (Fig. 1) so that it can be used easily and widely without change of existing norms and standards of color testing in the armed forces.

The details of Martin Lantern and its patent were also accessible on the internet at the website of the European patent office at esp@cenet.

Material & methods

All candidates of SSB, Allahabad, reporting for SMB (Selection Medical board) underwent color vision testing at the eye dept. These candidates were made to undergo the computerized eye test as well to compare the results with various forms of color vision testing currently available. In addition, patients in