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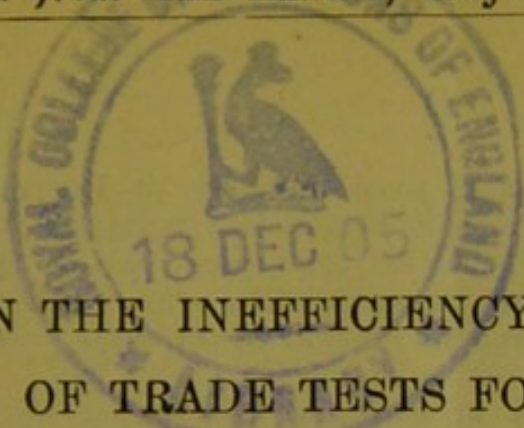
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ON THE INEFFICIENCY OF THE BOARD  
OF TRADE TESTS FOR THE DETEC-  
TION OF COLOUR-BLINDNESS.

BY F. W. EDRIDGE-GREEN, M.D. DURH., F.R.C.S. ENG.

WHEN I read a paper over 11 years ago drawing attention to the inefficiency of Holmgren's test for colour-blindness not a single one of the specialists who heard my paper agreed with me; now I do not know of a single man who has specially devoted attention to the subject who would say that this test is an efficient one. But there are many who, though acknowledging that the test is not an efficient one, still adhere blindly to the theory and method. I hope to be able in this paper to show that a test to be efficient must be based upon the facts of colour-blindness and not upon any theory.

It would surprise the public and those in authority if they knew how many colour-blind men there are in the seafaring and railway professions, but I am, of course, absolutely prohibited from giving the name of any colour-blind man who may consult me to his employer without the consent of the man in question. Incredible as it may seem, shipowners are able to and do employ colour-blind officers who have been rejected by the Board of Trade, and who may have been discharged by other companies for nearly causing accidents.

The reports of the Board of Trade show that Holmgren's test has been used by the Marine Department since September, 1894. Let us consider whether there has been any improvement in the results obtained since the adoption of the test. The percentages of failures in colour vision since 1885 are as follows: 1886-86, 1.39; 1886-87, 1.12; 1887-88, 1.01; 1888-89, 1.03; 1889-90, 0.94; 1890-91, 1.19; 1891-92, 0.82; 1892-93, 1.17; from June, 1893, to August, 1894, 1.27; from September, 1894, to December, 1895, 1.39\*; and from January to December, 1896, 1.02; from January to

December, 1897, 0·67\* ; and from January to December, 1898, 0·81. The percentage is really less in those years marked with an asterisk, as in each year one of those rejected passed on appeal in the subsequent year. This is in addition to those who passed on appeal in the same year as the examination.

It is not my intention to give in this paper all the objections to Holmgren's test, but only to show that in practice the results have been as I predicted. Anyone who wishes to consider the subject in all its details will find these objections in full in my book on "Colour-Blindness" in the International Scientific Series. I can only say that my nine years' subsequent experience of the subject only makes me more certain of the statements I have there made. One of the chief arguments that was used by the advocates of this test against the old tests of the Board of Trade was that, as the known percentage of colour-blind persons in the community was at least 4, a test that detected a little over 1 per cent. must be inefficient. But it will be seen from the above figures that the percentage of those rejected has not been increased since the alteration in the method of testing. This is all the more worthy of note because candidates are able to be examined for the colour test alone. The percentage for the last two years is very low.

I may mention incidentally, in order to show the unreliability of this test to detect colour-blind persons, that I have examined a man who was so colour-blind that he could not see a red light at all, and yet he passed this test with ease.

Not only does this test fail to detect colour-blind persons but normal-sighted persons are rejected by it, particularly when the examiner adheres very carefully to the directions accompanying the test. It was never suggested that other than colour-blind persons were rejected by the older tests. Those who criticised the tests always declared that they were not stringent enough. It will therefore be seen that the test is more inefficient than that previously used. Of those who were rejected as colour-blind in 1895 21 appealed and eight were found to have been wrongly rejected. I may also mention that another passed at a date later than that of the report. Of those rejected in 1896 12 appealed and five were found to be normal-sighted. In 1897 nine were re-examined on appeal and of these one passed and eight were rejected. The number of officers already in possession of certificates who on coming up for examination in the year 1897 failed to pass the sight test was seven, one mate and one second

mate failing in form-vision, while two mates and three second mates failed in colours. The second mate who failed in form-vision passed on re-examination, and one of the three second mates who failed in colour-vision afterwards appealed and passed. Of those rejected in 1898 for colour-blindness six were re-examined on appeal and one passed. It will be noticed that only a small proportion of those rejected appealed.

In order to show how normal-sighted persons are rejected by this test I will relate the following case. A man was sent to me as colour-blind. On examining him I found that he was normal-sighted. I then examined him with Holmgren's test, carefully adhering to Holmgren's directions. He put several confusion colours with the test green but no greens. In answer to my inquiry he said that all were of the same colour. I then said, "Are they all greens?" He replied, "No; they are not. That is a purple-brown, that is a grey, and that is a yellow. You did not tell me to put only greens with the wool you gave me: you said, 'Pick out all of the same shade or colour.'"

The question then comes up for consideration, What are the differences between matching and naming colours? When a person is asked to name a colour without being allowed to compare it with other colours he has to compare the present impression of colour with those impressions already in his mind. In order, therefore, that he may be able to name colours he must at least have an elementary knowledge of colour names. A person who has been educated with regard to colour will be chiefly influenced by colour, but a man who has only an elementary knowledge of colours will be influenced considerably by shade. If we compare the two methods with persons belonging to the educated classes we shall see how inferior the method of matching is to that of naming. Let us take 150 wools and examine two similar colour-blind educated persons with them. The first is asked to classify the wools, putting all those of similar colour together; the second is asked to name the whole of the wools one by one. It will be found that the second person will make very much more numerous mistakes than the first. The reason of this is obvious: in the case of naming colours the person has only the impression present in his mind to enable him to name a colour correctly; in the case of matching colours he has other colours present with which he can compare the test. We all know what to do when we are doubtful what to call a

colour—namely, compare it with some other colour about which there is no doubt. Slight differences of colour become more marked on comparison.

It has always seemed to me an anomaly that in testing the colour perception of an individual we should ignore colour names as Holmgren says that we should do. I contend that it is absolutely necessary that the person to be tested should pick out the colours as colours and not as shades. It is not necessary that he should know the names applied to nondescript colours but only the names of the fundamental colours—red, yellow, green, and blue. If we test a person without making him clearly understand that he is to match the wool by its colour and not by any other quality we are very likely to reject normal-sighted persons as colour-blind. A man who names a green light as red must either be colour-blind or dangerously ignorant of colours. I have never met with a case of the latter kind and doubt whether it could be met with in the class of men tested. The Board of Trade have used a test for colour ignorance, but no failure to pass the test has been reported.

One very common mistake which many writers on colour-blindness have made is that colour-blind persons guess the names of colours when naming them. I can say most emphatically that they do nothing of the kind—at least, until they know they are colour-blind. A colour-blind person names colours in accordance with his colour perception and thus shows definitely to which class he belongs. A man who did guess would know that he was incompetent. As a colour-blind person is rarely aware of his defect he answers as he sees. He does not guess because he feels certain that he is right, and therefore in all good faith would run a ship or a train to destruction. It must be remembered that the colour-blind have never seen colours as the normal-sighted see them.

I will now give another example of the effect of ignoring colour names. The following case is recorded in the report of the Board of Trade. A sailor was examined on June 9th, 1894, by the old tests and failed. He made the following errors as to coloured lights. He designated pink as green, green as neutral or blue, and bottle-green as salmon. He was examined again on July 7th, 1894, and he again failed. He called pink green and green neutral. After the introduction of the new tests he appealed and has been specially re-examined and passed! This is the result of the absurd neglect of colour names when examining a person as to his

colour-vision. I have no hesitation in saying that this man is colour-blind and was rejected rightly in the first instance by the old tests. Could a normal-sighted person after four and a half years' experience at sea mistake pink for green, green for neutral, or bottle-green for salmon? It will be seen that the man made the ordinary mistakes of the colour-blind and even used such terms as "salmon."

A very simple illustration may help to make my point quite clear. Let it be supposed that I wish a man or a child to separate a roomful of people into men and women. I take him to the room and say, "Now I want you to separate those persons. I want you to put all that look alike in one class and the remainder in the other." When I return I find that he has put all the big people in one class and all the small people in the other. If I then say, "You have classified them wrongly, I wanted you to put the men in one class and the women in the other," he could reply, exactly like the man who was wrongly rejected by Holmgren's test, "Why did you not tell me that you wanted me to separate them into men and women?"

A person with central scotoma will escape detection if examined by this test. For example, I examined a person with central scotoma with my pocket colour-test (in which small pieces of coloured material are ranged in rows) and found him perfectly colour-blind with regard to red, green, and grey. I then examined him with Holmgren's test and he went through it correctly with the greatest ease. As a light at a distance occupies the central portion of the field of vision, these persons will be found to recognise colours when close to them but not when they are at a distance. The red end of the spectrum may be considerably shortened, so much so that a person may scarcely be able to distinguish red from black. It is obvious that this will not prevent him from matching a light-green wool with other green wools.

When I ask a member of the general public whom he thinks are employed as examiners by the Board of Trade he almost always replies, "Trained oculists, of course," and is astonished beyond measure when I tell him that not a single medical man is employed either for conducting the ordinary examination or appeal.

The tests which I use are constructed on the facts of colour-blindness apart from any theory and so will hold good whatever theory be adopted. They are two in number. One I have called the "classification test" and the second

the "lantern test." The "classification test" is not essential but is a great help in ascertaining the colour perception of an individual. It consists of four test colours and 180 confusion colours, 150 coloured wools, 10 skeins of silk, 10 small squares of coloured cardboard, and 10 small squares of coloured glass. The whole series of colours is represented, both simple and compound. In addition, there are a large number of colours which have been chosen by colour-blind persons as matching the test colours. The test colours are orange, violet, red, and blue-green, labeled one, two, three, and four respectively. The whole series of colours is chosen with the view of presenting as much difficulty as possible to the colour-blind person and as little as possible to the normal-sighted person.

The apparatus of the lantern test consists of a lantern and 13 slides, seven slides containing coloured glasses and six containing modified glasses. The slides are numbered as follows:—Coloured glasses: (1) standard red (A and B), (2) yellow, (3) pure green, (4) standard green, (5) blue, and (6) purple. Modifying glasses: (7) ground glass, (8) ribbed glass, (9) neutral No. 1, (10) neutral No. 2, (11) neutral No. 3, and (12) neutral No. 4.

Space will not permit me to do much more than refer to these tests which are described in detail in my book on "Colour-Blindness." I will, however, mention the advantages which the lantern test possesses over Holmgren's. On account of the arrangement of signals by sea and land it is necessary that persons employed in the marine and railway services should be able to recognise and distinguish between the standard red, green, and white lights under all conditions in which they are likely to be placed. These conditions are represented by the test. The test demonstrates perfectly to an onlooker the incompetence of those rejected. The test demonstrates to the colour-blind person himself that he is colour-blind. In one combination a red light is shown, visible to the normal-sighted at a considerable distance. With the colour-blind if the red end of the spectrum be much shortened the red light will not be perceived at all. I have only to show a case of this kind to convince the most obtuse disbeliever in colour-blindness. The light is dazzling in its brightness and yet the person examined declares that the room is absolutely dark. Yet this man may have just passed Holmgren's test with ease. A person with central scotoma is at once detected as the light occupies the central point of the field of vision. In another combination the intensity

of the lights is altered so as to make them appear changed to the colour-blind whilst leaving them unchanged to the normal-sighted. With the unmodified lights the green is lighter and bluer than the red. When modified with a neutral glass the green appears the darker and yellower of the two, exactly as it does in a mist or fog. The two-unit colour-blind, therefore, at once call this combination red, because the colour is made to look so much like their red. I have not met with a two-unit colour-blind person who has named this combination correctly; the answer has almost invariably been "red," usually with some positive exclamation, as, "There is no doubt about *that* being red." The importance of this fact cannot be over estimated, because I have tested educated colour-blind persons who have found no difficulty in naming the colours when unmodified with the neutral glasses. These would be most dangerous persons at sea because they would deliberately mistake the red light for the green and *vice versa*. At the same time they would feel positive about the nature of the lights. It seems to me that in all probability this is how many accidents have occurred.

The material of the test is the best possible, as a coloured glass will not fade or become soiled like all dyed substances. Again, a coloured light has none of the accessory qualities which enable the colour-blind person to pass through other tests. Thus many two-unit colour-blind persons will call the yellow glass red or green who would not think of putting a yellow with a green or red wool on account of the difference in luminosity. The method is better than that of direct comparison because the candidate is forced to use his colour perception and has to compare the colour seen with previous impressions of colour in his mind. By the use of neutral glasses I have obviated the objection to the method of naming colours (namely, that an individual can distinguish between colours by their intensity) and forced the examinee to depend upon his colour perception and not upon some other accessory quality of the object seen. No amount of coaching will enable a colour-blind person to pass this test, whilst almost any other may be passed in this way. The test also has a quality possessed by no other—namely, that of enabling the examiner to reject dangerous persons and dangerous persons only.

It is incredible that the subject of colour-blindness and defects of sight in seamen and railwaymen should be so much neglected by those in authority, as it ought to be



evident to every thinking man that anyone who cannot distinguish red from green or who cannot see red at all is not a proper person to be employed in occupations in which it is necessary to distinguish between these colours. I know of no case in which, an accident having occurred through a sailor or engine-driver mistaking the signals, the man's sight has been examined at the subsequent inquiry to see whether he was colour-blind or his sight defective in any way. In accidents which have seemed to me to have occurred through colour-blindness, others as well as myself have written to the authorities asking, but ineffectually, that the men's sight should be examined. At the same time the men examined have a right to expect an efficient test conducted by a properly qualified medical man. We ought not to hear of so many cases of normal-sighted persons being rejected as colour-blind. Let those in authority put themselves in the places of the unfortunate officers who have been wrongly rejected.

As I propose shortly to give several demonstrations of colour-blindness I should be glad if anyone who would like to be present would communicate with me. I should be glad to test then any doubtful case of colour-blindness, especially one which has escaped detection by any of the tests in ordinary use

Hendon.