THE USE OF COLOUR TESTS IN MEDICAL AND SURGICAL PRACTICE.*

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MODERN methods of colour vision testing are due to the work of Edridge-Green, and the present-day use of his lantern increases *pari passu* with the disuse of Holmgren's wools.

Some interest in the subject of colour tests was aroused by the reading of three papers at the annual meeting of the British Medical Association, held at Bournemouth in 1891. At that time on most of the railways and in the shipping service the testing was done by lay officials and seldom by surgeons; the colour test was often merely a variegated sheet of paper, while the standard of form vision could be passed with sight that was only one-quarter of the normal. In the mercantile marine the exposure of the methods adopted and the standard required came as a surprise, I think, to most surgeons, and steps were at once taken by the British Medical Association to investigate the matter. A committee of ophthalmic surgeons was formed to make inquiries as to the regulations adopted in the United Kingdom, in Europe, and in the United States. The report of this committee fully confirmed the authors of the papers.

An attempt was then made to reform the methods of examination, more especially with regard to the railway companies. The success, however, was limited. The stumbling-block apparently was the fear that the transference of the testing from lay officials to qualified surgeons would involve expense. Only those who have had experience know how difficult it is to fight so huge a monopoly as the railway interest is. The *Times* and most of the great London papers backed up the movement. The Government was appealed to, but there the railway and mercantile marine influence was overwhelming. Mr. Bryce, then President of the Board of Trade, and now our Ambassador to the United States, was interviewed, but his reply was that the Government could not undertake to lay down rules, because if they did they would relieve the railways of responsibility. For instance, in case of an accident due to an error of sight on the part of a railway servant, if it were found that the regulations laid down by the Board of Trade had been followed, it would be difficult to prove that the company was answerable for the disaster. During the last twenty years it has to some extent been recognized, however, that "clerks and inspectors are not sufficiently acquainted with the science of optics and the intricacies of colour blindness to utilize the one in the detection of the other."

To those who are surgeons to railways and to marine companies the subject of colour tests is most important. For many years and down to quite recent times Holmgren's wool test was the best that was available, but in important cases it is now no longer relied upon by ophthalmic surgeons. Some form of lantern has superseded Holmgren's method almost universally, and as it is simple to use and more in accordance with the daily work of signalmen, whether on land or sea, it is absolutely essential that all who have colour testing to do should obtain a lantern—for choice, of the Edridge-Green pattern.

I would like to pay a tribute to Dr. Edridge-Green, the inventor of this apparatus. For years he battled with dogged perseverance against highly placed official opposition, and as his views to some extent were heterodox, and contravened the teaching of Helmholtz and Holmgren, his fight was a long and arduous one. Now his lantern and his method of testing colour perception are practically adopted by the Admiralty and all the higher branches of the public services in this country, and still more universally by ophthalmic surgeons.

The advantages of the lantern over the wool test are manifold. First, it is simpler to apply. The colours do not fade or get soiled by time and use. Many half-educated candidates fail to grasp the meaning of the term "shades" as applied to the lighter and darker colour-tints. It is easier to convince the friends that the rejection of a candidate is justified—a very important fact in the case of boys who are applying for admission to Osborne in order to

become officers in the Royal Navy. Still more important is the fact that some colour-blind people can pass the wool test. The lantern is a method of testing which resembles the actual signals in use by land and sea, and the obscurity produced by distance, fog, mist, or rain can be closely imitated.

Without going into details I will explain how the various colours are used. The two signal colours are, of course, red and green. The lantern can be arranged to show the red as seen on a foggy day; some colour-blind men, whilst recognizing the red as red under ordinary circumstances, will call it green when it is modified by fog. By varying the size of the diaphragm aperture we can represent the bull's-eye signal lantern as seen at 600, 800, or 1,000 yards.

Since the last railway strike the men have been agitating for an alteration in the method of vision testing, demanding that they shall be taken on the line and shown the lamps. This would be satisfactory if the signals were always seen under identical circumstances. But as the recognition of them is influenced by climatic variations, it is impracticable to carry it out. A man would have to be tested not only on clear and dark nights, but also on rainy, foggy, and misty days. With a clear atmosphere he may recognize the colour easily; but if he has shortening of the red end of his spectrum he may miscall it. I saw a boy a few weeks ago who had been tested by Holmgren's wools and passed by a surgeon as free from colour-blindness, and yet when he was examined at the Admiralty he was rejected. The friends refused to believe that he was colour-blind, and they were much astonished when I was able to demonstrate to them that, though his perception was accurate enough under a good illumination, yet when the light was reduced he called red green.

For surgeons connected with the railway companies and with the marine the lantern is quite indispensable, but there is a yet more important use for it, and that is for all practitioners who see cases of brain disease. The arsenal of no general hospital is quite complete that has not a colour-perception lantern. Take for instance a case of cerebral tumour in which the perimeter often shows, as was first pointed out by Bordley and Cushing, a contraction of the field for blue, so that it is no more extensive than that for red, and the boundaries of the two interlace. Normally, of course, the blue is considerably larger than the red. In these cases I find there is sometimes abnormality in the colour sense when tested by the lantern through a small aperture, although Holmgren's wools show no abnormality. Whilst much attention has been directed to the colour fields in disease of the brain, very little has been given to colour perception and discrimination in these cases. The thorough way in which physicians examine cases of brain disease for contractions of the fields of vision, for hemianopsia, and for scotomata, should, I think, be supplemented by colour perception tests by means of the lantern. In doing so it must not be forgotten that about 5 per cent. of men are congenitally colour-blind when tested by wools, and a higher percentage by the lantern. In ophthalmic practice the number of cases of intracranial tumour that one sees is limited, but in several that have recently come under my notice there has been a failure to recognize the violet end of the spectrum, more especially when the examination has been made with a small aperture so that the retinal image was minute. Loss of violet vision does not necessarily indicate the presence of a gross local lesion, such as a growth or a hæmorrhage; it may merely signify a general deterioration of the brain, with a consequent loss of a highly specialized and recently developed function.

It is well recognized that colour differentiation is much more acute than it was in the classical days of Greece and Rome. The Greek words for colours in many cases had a primary meaning that had nothing whatever to do with colour, and as a portion of the brain became adapted for the reception and interpretation of colour perception, so words already in existence were appropriated for their description. Naturally there was at first much confusion with regard to the differentiation and nomenclature of colours. The Greek word *glaucos* originally meant glancing or gleaming, and had no reference to colour (Liddell and Scott). Homer applies it in this sense to the sea, but later it meant pale blue or grey. The Romans used the word not only to describe the colour of the olive, the willow, and the vine (that is, what we should call green), but also they

* A paper read before the Bath and Bristol Branch of the British Medical Association.

applied it to precious stones (such as the topaz) when we should say blue. The eyes of Athena are described by *glaucois*, not because they were blue, but because they were gleaming or fierce. With regard to purple, the Latin word *purpureus* meant various shades of red, and the corresponding word in Greece was probably first applied to the troubled sea and meant dark; it was only later that it was applied more definitely to colour.

The Greeks recognized three colours only in the human iris—first, *glaucois*, the lightest tint; second, *xaropos*, the intermediate shade, (but previously meaning bright-eyed and having no reference to colour); and third, *melas*, the darkest shade.

A very early reference to colour occurs with regard to Joseph's coat, which we are told was of many colours, but unfortunately they are not enumerated.

The rainbow, to which we have equally early reference, does not appear to have fascinated the ancients because it was polychromatic. In the Bible and in Homer it was considered to be merely a sign to man, and the word *iris* was used for any bright coloured circle surrounding another body. In this sense it was applied to the eye, which of course is usually monochromatic. It is a significant fact that form vision in the days when Pompeii was a living city was so advanced that the statuary of Phidias and Polycletois is of unsurpassable perfection; nevertheless the colour sense, after making allowance for the effects of time, is crude, and the tones are monotonous, red and yellow predominating. The mural paintings and frescoes at Pompeii are artistically inferior to the bronzes.

As time wore on presumably the function of the temporo-occipital lobe became more and more detailed, and in Saxon and early English days colour sense was well advanced; as we see in the illuminated missals of those times.

The Moors early developed a refinement of colour recognition, and there is no doubt that the Crusades stimulated the appreciation of tints and shades which prepared the way for the wave of Byzantine gorgeousness which swept over Southern Europe. When the Renaissance set in it is probable, judging from the works of da Vinci and Raphael, that colour perception was almost as matured as it is to-day, and that it was also a most important factor in the extraordinary development and progress of art, in all its branches, which distinguishes the sixteenth century.

The diagram shows the higher visual cortex on the lateral aspect of the right cerebral hemisphere. The upper part of the dotted area (A) is devoted to the recognition of words, letters, etc.; the middle (B) to persons and places; and the lowest (C), the temporo-occipital or fusiform lobe, to the recognition of colours. The posterior part is concerned with form vision (D) and ocular movements.

The isolated position of the fusiform lobe renders it probable that when a lesion is a primary one in that part of the occipital lobe, the earliest symptoms would be confined to loss of colour sense. On the other hand, a lesion spreading from other parts of the visual area would probably render the patient blind before a diagnosis of loss of colour recognition could be made.

A lesion confined to both fusiform lobes would probably not interfere materially with form vision, the centre for which is further back (D), except that the negation of colour would tend to blend all objects in one harmonious neutral tint. Such was the vision of our ancestors some few thousand years ago. In the present day, however, a congenital case of total colour-blindness is rare, and still fewer acquired cases have been published. A one-sided lesion in the colour centre is occasionally met with, and probably they are more common than is acknowledged. A patient

so affected, in walking along a country lane, would have a green hedge on one side and a grey one on the other.

It is well recognized that there are symptoms which point to intracranial pressure which precede papilloedema and amongst these are, I believe, changes in the recognition of colour. The importance of these pre-papilloedematous symptoms lies in the fact that the tendency of present-day surgery is in the direction of early decompression operations.*

Although acquired colour-blindness has not been investigated very extensively, the more general use of the lantern by physicians will, I believe, lead to an extended recognition of its prevalence in cases in which the temporo-occipital lobe is involved.

The investigation of a patient's capacity to discriminate between colours is no longer a matter of academic interest alone; it is no longer associated in practice only with the examination of railway men and sailors; but it is becoming an additional aid in the diagnosis of localization. The area of usefulness of colour tests has become increased, and it is worthy of the attention of the physician and of the surgeon. As the sense of touch is investigated for the recognition of heat and cold, and also for the presence or absence of stereognosis; as taste is examined with regard to sweets and bitters, for salts and acids; so too should vision be analysed, not only with regard to form and fields, but also as to the discrimination of colours.

A NOTE ON THE RELATION OF CORNEAL AND ABSOLUTE ASTIGMATISM.

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The object of this communication is to ascertain the relation of corneal astigmatism, as recorded by the astigmatometer, to absolute astigmatism, as worked out by retinoscopy, the retinoscopy being done either under atropine, or, in the case of older patients, under homatropine and cocaine. All the observations have been made by myself, the instrument used being Javal and Schiötz's astigmatometer (the same instrument being always used), and the retinoscopy having been worked out always with a plane mirror, the shadows being reversed in every case.

The 500 cases have not been selected in any way, but have been taken consecutively from my private journals; in this way the possibility of individual difference has been excluded. The corneal astigmatism and the absolute astigmatism were worked out quite independently of each other; in many cases the corneal astigmatism was observed one day and the absolute astigmatism worked out on the return of the patient a few days later, in this way excluding the possibility of any tendency one might naturally have to make one observation confirm the other. The cases have been limited to 500, a number sufficiently large, at any rate, to warrant some generalization from, and a convenient figure. The notes kept of the different cases were in the ordinary course of practice, without any intention of using them in this way.

These 500 cases give 1,000 eyes, and the observations have been made with the following results:

Out of the 1,000 eyes examined the absolute astigmatism and the corneal astigmatism are the same in 475 cases—that is, 47.5 per cent.; 230 were hypermetropic, 353 showed compound hypermetropic astigmatism, 89 were myopic, 190 showed compound myopic astigmatism, and 138 mixed astigmatism. The divisions into the different classes of hypermetropia, hypermetropic astigmatism, myopia, myopic astigmatism and mixed astigmatism, were made by the actual figures found by retinoscopy.

In each case the lens which first turned the shadows was the one noted, so that it might be said in every case there was an over-correction. In the ordinary course many of those eyes were practically emmetropic, or at least emmetropic in one meridian.

*Research is needed with regard to the quantitative estimation of colour perception. Cohn, as long ago as 1879, pointed out that a spot of red 1 mm. square could be seen at 14 metres, whereas a similar sized violet one could only be named at 2 metres. (BRITISH MEDICAL JOURNAL, 1892, ii, page 626.)