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TESTING FOR COLOUR-BLINDNESS IN THE MERCANTILE MARINE.

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IN a former paper, "Homer Colour-blind," I very slightly touched upon the wider question,—one which possesses interest for most people,—colour-blindness, as affecting mankind in general and the mercantile marine in particular. Although the investigation of this remarkable phenomenon brought to light a curious fact, that on an average one male out of every twenty-five is quite unable to discriminate the principal colours of the spectrum, it excited no great deal of attention until it became apparent that, both on our iron-roadways and on the ocean, deplorable accidents were likely to—and often did—occur, from the colour-blindness of drivers and guards of railway trains, and of masters and pilots in charge of ships. It was at length fairly demonstrated that a certain percentage of persons employed on the railways, and in the Mercantile Marine Service, were, without being aware of it, unable to discriminate between the red and green signal colours in common use. Those who now offer themselves for employment on railways are, and have been for some years, subjected to a compulsory examination in colours, so that there no longer need be fear on this account. But as to the Mercantile Marine, the evidence adduced before the Royal

Commission on Shipping, now sitting, shows that the loss of life and property at sea has in no way diminished, has in truth materially increased, during the last ten years, out of all proportion to the increase of shipping, and it is alleged that a number of the collisions that annually occur is due to the colour-blindness of the navigating officer or the pilot in charge.

The Board of Trade, eight years ago, came to the decision—because of the serious consequences involved in the question of colour-blindness—that all masters and mates should undergo a test-examination in the following colours, *viz.*, red, green, blue, yellow, black, and white, before proceeding to an examination for a certificate of a higher grade. During the first two years, between May, 1877 and 1879, no less than 39 candidates failed to obtain certificates on account of their defective colour-sense. From this number twelve should be deducted, who were subsequently reported to have satisfied the examiners on a re-examination, leaving the actual number of failures from colour-blindness at 26.

After 1880 the result of failure to pass the colour-test was made equivalent to that of failure to pass the ordinary examination in navigation and seamanship,—that is, it prevented a considerable number of candidates from obtaining the certificates for which they applied.

The value of the colour-test soon became manifest to those in authority, and thereupon the Board of Trade, in February, 1880, after bringing their views to the attention of the Local Marine Boards, and receiving the concurrence of the majority of those Boards, resolved to extend the colour-test examination to all about to serve in the Mercantile Marine, and make it compulsory upon masters and mates to submit to the test. Consequently since March, 1880, all officers who for the first time applied for certificates of competency, in any grade, have been subjected to a colour-test examination, and if they failed in this they were not permitted to present themselves for the further examinations in navigation and in seamanship. In the event, however, of either a mate or master having already received a certificate of a lower grade, and presenting himself for one of a higher grade, and then failing to satisfy the examiner of his ability to distinguish colours, the higher grade certificate has been granted, with a statement written across it that "the holder has failed to pass the examination in colours." This has, no doubt, in individual cases operated prejudicially; it has prevented incompetent mates or masters from obtaining employment, but it is only right and just

that shipowners should be in a position to protect themselves. No case of hardship has, however, come to the knowledge of the Board: furthermore, to guard against injustice or a hasty judgment on the part of the examiner, a candidate may, on the expiration of three months from his first examination, apply to be re-examined for a second and third time, and by a later order he can obtain the permission of the Board of Trade to be again tested in colours for the fourth and last time.

By the extension of the colour-test to all persons, any man or boy about to enter the Mercantile Marine can satisfy himself and his friends of his ability to distinguish the colours of the flags and lights in use on board ship. These optional examinations have also been the means of preventing those who are unable to name colours from taking to the sea at all as a means of livelihood.

It is a matter of considerable regret that the colour-test has not been made obligatory upon pilots and men on the "look out," as well as upon masters and mates. Pilots claim the right to navigate all ships as soon as they near our coasts, and it is of the very gravest importance that they should make no mistake as to the lights displayed by other ships. This omission is entirely owing to a divided authority, the pilot service being exclusively under the control of the Trinity House, a body alleged to be somewhat addicted to placing obstacles in the way of scientific progress.

The mode of conducting the colour-test examination is of a threefold nature—by coloured cards, wools, and glasses. The examiners are supplied with selected boxes of each of these, and the examination commences with the cards, the most important daylight test being red, green, and black: if the candidate is able to distinguish and name the colour of each it is sufficient, and he obtains his certificate. The standard red and green glasses are of the same colours as the "port" and "starboard" lights of a ship, and these are used in a darkened room, a lamp being placed behind them. The testing by coloured glasses follows that of cards or skeins of wool, special attention being paid to the candidate's ability to distinguish the red from the green glass. The examination on the whole is made with a view of determining whether a candidate can distinguish signals by day,—as flags, which are composed of many colours,—and next whether he can distinguish signals by night,—the lamps carried by ships, which are either red, green, or white. If, therefore, a man can distinguish red from green, and both

from white or black, the examiner considers that he will be able to follow the International Rules for the prevention of collisions at sea. This method of testing has, we are told, been found sufficient for the purpose for which it is applied, "that purpose being not to discover and record the peculiarities of sight of the applicant, nor his powers of detecting and arranging all colours and tints, but to test his ability to name a common well-known colour when it is placed before him."

Candidates can hardly be expected to complain of the easy-going method sanctioned by the Board of Trade. Nevertheless it will occur to members of the medical profession that it is capable of a good deal of improvement. First, to be thoroughly effective the examination should undoubtedly be made more practical,—that is, quite in accord with the conditions under which the recognition of coloured signals at sea will usually take place. Second, the examiners should, for obvious reasons, be trained men, well acquainted with the subject, and not retired ship-captains. With examinations more intelligently conducted than at present, it could hardly happen that so large a proportion of the candidates who on their first examination called green red, and red green, would upon re-examination obtain certificates.

The Board of Trade, however, with every desire to do its best, in 1881 endeavoured to ascertain the practice adopted by other nations, and a circular was issued to the principal powers of Europe, as well as to America. From the answers we gather that a colour-test has been in use in the United States for some years. In the case of pilots applying for the renewal of their licenses, or of applicants for original licenses as pilots on steam-vessels, examination is compulsory, and since 1880 a voluntary examination for all persons serving in the Mercantile Marine, as to physical fitness and ability to distinguish colour, has existed.

In the voluntary examination, the system known as "Holmgren's worsted test" is used; and the medical specialists who conduct them say that it has proved fairly satisfactory. With regard to European countries, Austria and the Netherlands are the only nations that have introduced a colour-test examination into their mercantile marine services, while France and four other nations have introduced a colour-test into their naval schools and State navies only. Belgium has instituted a compulsory examination for *employés* in mail-boats running between Dover and Ostend. Holmgren's method is used, and, in addition, all Antwerp

pilots are examined by two ships' lights, red and green, presented at 10 metres distance from the candidate; the position of the lights being changed rapidly. Flushing pilots are examined by means of different shades of colour thrown upon a black background: while Ostend pilots have a number of pieces of wall-paper, or skeins of wool, of different shades of colour placed before them, and these they are required to group into the colours of the spectrum, a copy of which is placed before them.

Duly considering the various modes of conducting the examination practised by other nations, the Board of Trade came to the conclusion "that there was nothing in the colour-tests, or mode of applying them, as adopted by other countries, which, for practical purposes, is an improvement upon those in use in this country." But while it is thought to be undesirable to make any alteration in the mode of applying the colour-test in this country, it is admitted to be necessary to apply it more generally, and that "an examination in colours is needed, not only for officers, but for pilots and men on the 'look out.'" This will scarcely be made compulsory on all alike so long as shipowners affect to despise, or disbelieve in, the dangers arising from colour-blindness. An ignorant determination to reject all proofs on this score bars the way to the adoption of preventive measures.

As to the results of the past four years' examinations, from May, 1880, to May, 1884, when the colour-test was made compulsory, a great many curious mistakes, it appears, were made in colours by the 85 candidates who presented themselves for certificates: not all of whom were rejected, for 29 applied to be re-examined, and ultimately succeeded in satisfying the examiners. It should be observed, however, that the greater part of them were re-examined in provincial towns, and were said to be able to distinguish between red and green. Beside these 85 failures, there were also 55 failures reported in examinations for colours only. This, I assume, implies that a number of persons voluntarily offered themselves for the colour-test certificate before going to sea, and paid their shillings to satisfy themselves of their inability to distinguish colours commonly in use.

Many typical cases of complete and incomplete colour-blindness are given, and the subjoined summary more clearly shows the particular mistakes made by the 85 candidates already referred to.

Colours of cards or glasses.	Green.	Red.	Yellow.	Blue.	Other colours.
Green described as	—	79	16	13	13
Red „	24	—	3	3	3
Yellow „	9	38	—	1	2
Blue „	45	2	1	—	4
Black „	4	2	—	—	3
White „	3	1	—	—	—

Since the report does not state the total number of persons examined within the year, or the past four years, I am unable to give the exact percentage of rejections; but it may be assumed that it does not greatly differ from that of 1877 and 1878, which was rather under $\frac{1}{2}$ per cent. It is believed that last year it stood rather higher, 0.56 per cent.

The hereditary nature of colour-blindness is a curious feature in the case. It is apparently known to but comparatively few persons that colour-blindness is transmissible, affects the human race in different degrees, is an incurable physical affection, and remarkable enough is chiefly confined to the male branch of families. A select instance or two from among many will serve to impress the first feature on the memory. In a family of seven children, four sons and three daughters, the sons are more or less colour-blind. The defect in this case is inherited from the grandfather, through the mother, whose vision, as also that of her three daughters, is quite normal. In another family of five children, three sons and two daughters, the sons inherit the colour-blindness of their father and grandfather, while the two daughters, and, indeed, all the females, for three generations at least, have been free from any colour defect.

My reason for referring to the hereditary nature of colour-blindness is that I wish more particularly to enforce a duty upon parents, one they owe to themselves and their children, that of making due inquiry into every peculiarity or defect of vision which may have constituted a family failing, before yielding to the wish of a son for a sea-faring life. The inability of a boy to distinguish colours commonly in use should at once settle the question of his taking to the sea at all.

Colour-blindness is, to some extent, aggravated by age, just as is the case with certain other defects of vision. It apparently may be developed in after life, and as the near point of vision recedes. The Academy at this moment furnishes abundant examples, and which seem to justify the criticism that “yards of garish canvasses wanting in ideas,

composition, drawing, and colour" cover its walls. To what other cause, if not to a great deterioration of the colour-sense, or to colour-blindness, can this great falling off in the works of artists be attributed?

As to the physical nature of colour-blindness, no entirely satisfactory explanation has been offered. Hering advanced a plausible theory that colour is the mental perception of the changes taking place in the visual substance, which, under the influence of light, is constantly undergoing a double process of disintegration and reparation. Perception of white light being coincident with disintegration; of blackness with re-integration; the degrees of white and black depending on the activity of the processes of disintegration and repair. But of the many theories promulgated, that known as the Young-Helmholtz is regarded as the most acceptable. According to this theory, the retina has three kinds of colour-perceiving elements, the stimulation of which gives respectively the sensation of red, green, and violet. White light excites all the elements equally, but if monochromatic or homogeneous light be received upon the retina, then each of the three kinds of fibres are simultaneously stimulated, and with an intensity that varies with the length of the waves. Thus, red light, which has waves of the greatest length, stimulates the red elements strongly, the green more feebly, and the violet only slightly, consequently the sensation experienced is red. Green, which has waves of intermediate length, stimulates the red and the violet feebly, and the green elements strongly, and the sensation perceived is green, and so with the violet, which has waves of the shortest length, and which acts as a powerful stimulus to the violet elements of the retina, and scarcely affects the green and red elements at all.

From what I have stated it may be understood that there are three kinds of colour-blindness corresponding to the three colour-perceiving elements: red blindness, green blindness, and blue or violet blindness. Of the several layers of which the retina is made up, it is the layer of rods and cones that is concerned in the production of light and colour. Schultz believes that they both serve as elements of light, although the perception of light is the more immediate function of the rods, while that of colour exclusively belongs to the cones; should these be congenitally absent or partly developed it follows that the retina, and consequently the eye, must be insensible to certain portions of the spectrum colour-blind.

The physical and physiological bearings of the colour sense are too vast and important to be disposed of within a brief space ; I must therefore content myself by stating for the present that the range of human vision, like that of hearing, is subject to great variations in different individuals, and that a great disproportion exists between the actual number of natural colours and the limited amount of sensory colours. The conclusion to be drawn from this observation is, that, "normally every visual mechanism is physically and physiologically fitted to respond to but a small number of the great bulk of natural colour vibrations, and thus virtually proving that every such mechanism is truly colour-blind."—(*Oliver*). It has been said of Chevreul that he was able to distinguish 14,420 tones of colour ; more recently, too, it has been found that the human eye is totally unable to receive all the vibrations of colour which must exist in the spectrum. We know that it does not recognise the terminals of either end—the red and violet—and how many unrecognised natural colour differences actually exist between the red and the violet ends of the ordinary spectrum. Through the want of power of perception in the retina it is quite impossible to say or imagine.—(*Oliver*).
