with a contracted and contemptible class conceit, but with broad human sympathies, tempered with that just professional pride which is one of the strongest incentives to sacrifice for any work which tends to foster professional unity or to raise our calling in public usefulness or esteem. Such a professional pride is the surest safeguard of professional probity.

NEW INVESTIGATIONS ON THE FURTHEST LIMITS OF COLOUR-PERCEPTION BY DIRECT SUNLIGHT AND BY ELECTRIC LIGHT.*

BY PROFESSOR HERMANN COHN, Breslau.

THE distance at which the colours of different coloured papers can be recognised has not as yet been unanimously decided. Donders has said that, by good daylight, papers of 1 millimètre square in each colour can be recognised at 5 mètres distance. For 5 mètres, Dor and Weber found 2 millimètres for green, and 3 millimètres for red, as the diameter of the circle necessary for recognition of its colour. For yellow, Dor gives 2½ millimètres; Weber 5 millimètres: for blue, Dor 8 millimètres; Weber 5 millimètres.

In order to ascertain the extreme distances for perception of colour by the best illumination, I tested by the electric light the eyes of some physiologists who possessed normal acuteness of vision; and I found at my first experiments, by aid of Weber's chromometer, that many people recognised colours three or four times further off than Weber had calculated for daylight (see *Archiv für Augenheilkunde*, Band viii, Heft 3, p. 408).

What was my astonishment, however, when, with arrangements specially made for this purpose, I found that the largest room in the Physiological Laboratory was not long enough. The doors of a number of adjoining rooms had to be opened, in order to give a space of thirty mètres in length, to find the extreme boundaries for the recognition of coloured points of from one to two millimètres diameter upon a dark background.

I used the Heidelberg flower-paper which Weber employs in his chromometer, cut in bits of one millimètre square, and fastened each on a large surface of black velvet. The electric light was produced by a gramme machine of three-horse power and one hundred rotations in the minute, and was placed in front of the visual object at a distance of one mètre. The medical men and physiologists who were examined looked through a Weber's tube, in order to keep off all lateral light, which, however, was but weak, as the experiments used to be made from nine to eleven in the evening. The eyes examined were either emmetropic or slightly myopic (0.5 to 1.0), and in the latter case were corrected with concave glasses. Each eye was tested separately, and the following results were obtained with papers of one millimètre square.

1. Red appeared bright at from 16 to 17 mètres distance; distinctly red at from 11½ to 15 mètres.
2. Green appeared bright at from 20 to 24 mètres; distinctly green at from 8 to 14 mètres.
3. Blue appeared bright at from 8 to 10 mètres; but not distinctly blue beyond 2, 4, or 8 mètres.
4. Yellow appeared bright at from 15 to 20 mètres; but not distinctly yellow until at from 1 to 6 mètres: up to that point, there was always great hesitation as to whether the object was white or yellow.
5. White appeared bright at 20 mètres. At from 16 to 20 mètres, it was usually recognised as white; but yet often mistaken for yellow up to 6 mètres distance.
6. Orange appeared bright at 24 to 25 mètres; reddish at 13 to 15 mètres; reddish or yellowish at 8 or 9 mètres; not distinctly orange until from 3 to 7 mètres.
7. Violet caused the most difficulty. It appeared first as a bright point on a dark ground at from 11 to 13 mètres. Only at from 1 to 4 mètres was it seen as violet or blue.

It was now important to make similar tests with the same papers by direct sunlight in the open air. So far, such measurements are wholly wanting. In the garden, on sunny days, between 9 and 11 o'clock in the forenoon, eleven eyes were examined. The coloured papers, fastened on black velvet, were placed in the direct sunlight, while the individual under examination stood in shadow and looked through a Weber's tube.

1. Red was recognised certainly as red at from 10 to 17 mètres; exceptionally at 19 to 22 mètres; but was seen as a bright point at 20 to 22 mètres.

2. Green was seen certainly as green at 4 to 11 mètres; exceptionally at 21 mètres; at 22 to 32 mètres, it was seen as a bright point; at 12 to 18 mètres, usually as bluish or whitish.

3. Blue was seen certainly as blue at 4 to 9 mètres; exceptionally at 11 to 17 mètres; often mistaken for green at from 8 to 14 mètres; seen as a bright point at 14 to 22 mètres.

4. Yellow appeared at 35 to 40 mètres as a bright spot; but no one could say whether it was yellow or white. It was seen as yellow at 3 to 9 mètres; occasionally at 17 to 22 mètres.

5. White appeared as a bright spot at from 22 to 27 mètres distance; but here also it often could not be said with certainty whether it was white or yellow until the distance of 2 or 3 mètres had been reached.

6. Orange was seen at from 21 to 36 mètres as a bright point; at 17 to 20 mètres, usually as reddish; usually as orange at 5 to 8 mètres; often, however, not until 2 mètres was reached; and rarely at 16 to 22 mètres.

7. Violet was seen as a bright point at 19 to 22 mètres; then as grey-red, whitish, orange, sometimes white, and not certainly as violet until 1 to 3 mètres distance had been reached. One medical man recognised it as violet at 7 and 14 mètres.

These observations show that the boundaries for most colour-perceptions have hitherto been calculated too low. For the very variable diffused daylight, the numbers given by Donders, Dor, and Weber may perhaps be admitted.

On an average, colours of 1 millimètre in diameter will be seen—

	By Direct Sunlight.	By Electric Light.
Red....	At 14 mètres.	At 13 mètres.
Green..	At 7 mètres, further off mistaken for blue.	At 11 mètres, further off mistaken for blue.
Blue...	At 7 mètres, further off mistaken for green.	At 6 mètres, further off mistaken for green.
Yellow..	At 6 mètres, not distinguishable from white.	At 3 mètres, not distinguishable from white.
White..	At 30 mètres, not distinguishable from yellow.	At 18 mètres, not distinguishable from yellow.
Orange..	At 5 mètres.	At 5 mètres.
Violet..	At 2 mètres.	At 2 mètres.

I am now engaged in investigating the question of increase of the distance for recognition of a colour with increased diameter of the visual object.

ON EXAMINATION FOR COLOUR-BLINDNESS.*

By H. R. SWANZY, F.R.C.S.I.,

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THE subject of congenital colour-blindness has for the last two years occupied much of the attention of ophthalmologists in Germany, in Norway and Sweden, and also in America. In Great Britain and Ireland, however, it has not been investigated with that thoroughness which its physiological interest and practical importance demand. It is true that to the writings of three Englishmen we are indebted for some of the earliest investigations concerning the chromatic sense and colour-blindness, namely, Young, Dalton, and Wilson of Edinburgh; but since their days the subject has not been cultivated by us. I desire briefly to bring under the notice of the Section some of the methods for examining the colour-sense which are now in use, and some of the observations which have been made as to the frequency of this anomaly.

Before doing so, permit me, sir, to refer to the two great rival theories of colour perception at present existing. The older of these is known by the names of two great men, as the Young-Helmholtz theory. It assumes three kinds of elements in the retina for perceiving respectively red, green, and blue (or violet). In accordance with this theory, three different kinds of colour-blindness are recognised, red-blindness, green-blindness, and blue-blindness. The Young-Helmholtz theory is still held by some as the true one; but a large proportion of those competent to form an opinion, and who have carefully investigated the question, have adopted the theory of the colour-sense as propounded by Professor Hering of Prague in his paper laid before the Vienna Academy on May 15th, 1874. According to Hering, there exist in the retina three kinds of perceptive substance: 1. The substance which perceives the

* Read in the Subsection of Ophthalmology at the Annual Meeting of the British Medical Association in Cork, August 1879.

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white-black row of sensations; 2. That for the red-green row of sensations; 3. That for the blue-yellow row of sensations. We are here concerned with the two latter substances alone. In accordance with Hering's theory, there are but two kinds of colour-blindness, red-green colour-blindness and blue-yellow colour-blindness. Red-blindness involves also green-blindness, and *vice versa*; while blue-blindness and yellow-blindness are also inseparable.

It would be outside the scope of this paper, and the discussion which it is to open, were I to follow Professor Hering into any of the manifold proofs upon which he founds his theory, or to consider the respective merits of these two theories; nor dare I occupy your time with details with which you are doubtless familiar.

A good test for the colour-sense must fulfil the following desiderata. 1. It must be capable of rapidly detecting the existence and nature of the anomaly. 2. It must make the least possible demand upon the intelligence of the patient. 3. It must render deception, whether intentional or unintentional, impossible; and, therefore, any method which depends on the correct name being given to the colour is bad. 4. The possibility of any interference of the judgment must be excluded, in order that the sensation to be tested may alone come into play. The spectroscope is naturally the first apparatus which suggests itself for the purpose in hand; but, employed alone, it answers none of the above requirements, and can only be employed as an adjunct to other methods.

A very beautiful method is that by means of coloured shadows which Dr. Stilling of Cassel was the first to employ for testing the colour-sense, although the experiment itself is not a new one. The experiment is made in a darkened room, by the help of a sheet of white paper fastened on the wall, a lighted lamp, and some pieces of coloured glass. A coloured glass is held between the lamp and sheet of white paper in such a way as to throw a coloured light upon the latter. Then a pencil or a penhandle is held before the paper. The shadow of this on the paper will be found to be coloured, and its colour will be seen to be complementary to that of the glass. If the glass be green, the colour of the shadow will be red; if the glass be blue, the shadow will be yellow. If the individual under examination see that the shadow is coloured, he must, of course, have the power of distinguishing both that colour and the colour of the glass; and if he be not able to see that the shadow has a colour, if it seem to him to be simply a dark shadow, he must be blind both for the colour of the shadow and for that of the glass, and practically such is found to be true. The experiment thus affords a very strong argument in favour of Hering's theory.

Dr. Stilling has also introduced a method of his own by means of pseudo-isochromatic tables. The tables which I exhibit to you are for testing for red-green blindness. They consist in letters and figures in pink and red upon a brown background. Brown and red appear to the red-green blind as similar colours; consequently in such a case the letters and figures should not be distinguishable. These tables have not met with universal favour. My own experience with them is I confess small, but of a kind to make me doubt their utility. At least one person who was markedly red-green blind by Holmgren's test could readily decipher the figures and letters on these tables.

Dr. Daas of Kagerö has published a table with coloured wools arranged in ten rows. Each row contains seven colours. In two of the rows (the eighth and tenth) the colours red and green are of the same kind, but different in shade. The other rows contain colours of different kinds. Each row is pointed to in succession, and the individual asked if the colours of which each is composed are similar or different. If he answer correctly in every instance, his colour-sense is normal. Rows one and two are for the detection of blue-yellow blindness. Rows three, four, five, six, seven, and nine are for the detection of red-green blindness.

The method of Professor Holmgren of Upsala has received the greatest meed of popularity. It is conducted by means of coloured wools. In the first instance, a light green woollen skein is laid before the individual, and he is required to pick out from the others all skeins of the same colour as the pattern. If this test be passed, the individual's colour-sense is normal. If it be not passed, a purple wool is placed before him, and if he succeed in matching it his colour-sense is merely imperfect. If, in addition to purple skeins, he match the purple pattern with blue or violet, he is completely red-blind. If, in addition to purple, he add green or grey, he is green-blind. If, in addition to purple, he add red or orange, he is blue-blind. The examination may end with this second or purple test, or the third or red test may be proceeded with. A bright red wool is laid before the individual, and if he be red-blind he will match it with green and brown shades which are darker than the pattern, if he be green-blind he will match it with green and brown shades which are brighter than the pattern. By this means, the colour-sense of an individual may be tested

in the space of a minute or a minute and a half, while no word need be uttered on either side, and a large roomful of other people about to be tested may look on without vitiating the test.

Finally, I must refer to a method which seems to be the one in use in these countries upon railways and other public services in which a colour-sense is essential for efficiency. It consists in such a card as this, with four coloured squares, red, green, yellow, and blue, each about an inch square. The person to be examined is simply asked to give its name to each colour. If he name them correctly, he is passed; if he give them the wrong names, he is not passed. Such a plan is full of fallacies. We know now very well that colour-blind people may be able to name colours correctly, but they do so, not by aid of their colour-sense, but by virtue of the brightness which one colour possesses as compared with another. Again, some uneducated people are not familiar with the names of colours, and in this way may seem with such a test to be colour-blind when not truly so.

Professor Cohn has employed in his investigations a modification of Holmgren's method by omitting altogether the first or light green test, and using only the second or purple test. It is a very suitable test from the point of view of the Young-Helmholtz theory, being a compound of the two extreme colours of the spectrum. It also is conformable to the theory of Hering, because, purple being a mixture of blue and red, it can detect every kind of colour-blindness. For red-green blind persons, it contains a colour they cannot see, namely, red; and for blue-yellow blind persons it contains a colour they cannot see, namely, blue. In using the test in this way, Cohn prefers rose-colour, which is a pale purple, to the dark purple recommended by Holmgren.

The principal observers of late as to the frequency of colour-blindness have been Holmgren, Cohn, and Magnus of Breslau, and Joy Jeffries of Boston. The latter distinguished oculist has personally tested the colour-sense of the enormous number of 18,329 individuals, and he gives the results of his labours in his book on *Colour-Blindness: its Dangers and Detection*, published two months ago. Donders, Fontenoy, and others have also examined large numbers with the same object. The percentage of colour-blind males found by these different observers varies from 2.87 by Dr. Fontenoy to 6.6 by Professor Donders and Dr. Minder of Berne. Amongst females colour-blindness is extremely rare. The highest percentage is given by Dr. Minder at 1.3. Cohn did not meet with a single colour-blind female in 1,061 whom he examined, and Magnus only one in 2,216. Joy Jeffries found four colour-blind females in the 7,942 who were examined by him, or an average of only .052 per cent.

I have myself examined 1,320 persons in respect of their colour-sense by aid of Holmgren's test. Of these, 90 were females, and none of them were colour-blind. Of the 1,230 males whom I examined, I found 82 more or less colour-blind, or a percentage of 6.6. I hope to add to these numbers and to make my investigations more complete in several particulars, especially as regards the search for blue-yellow blindness.

Most of the investigations of which I have briefly given the results were made with the object chiefly of ascertaining the prevalence of red-green blindness, for the practical reason that red and green are the colours employed for signals on railways and at sea. In the course of their investigations, the authors happened on some cases of blue-yellow blindness, but I think it is to be regretted that they did not keep it more specially before their eyes than they seem to have done. Cohn and Stilling alone have sought for it specially. Red-green blindness is, however, without doubt very much more frequent than blue-yellow blindness; Cohn met with only five cases of the latter, and Stilling with but seven. Cohn's investigations with regard to colour-blindness are by far the most valuable and complete which have as yet been made. He examined each of his one hundred colour-blind individuals by all the methods I have mentioned as well as by others. In this way, he has shown the very great probability of Hering's theory by demonstrating that everyone who is blind for red is also blind for green, and *vice versa*.

The very great interest which attaches to congenital colour-blindness for physiological reasons is only exceeded by its practical importance. No one would desire to travel by a railway train, the engine-driver of which was red-green blind, nor to know that the helmsman or look-out of his steam-ship had the same defect. I believe that a few accidents have been ascertained to have occurred in consequence of colour-blindness. But it will never be known how many have occurred in consequence of it, especially at sea, but which have not been traced to it, because the profession and the public have been too little alive to its existence and unacquainted with the proper methods for its detection.

It would be most desirable that investigations such as those to which I have referred should be made in this country, and that the various railway companies and the Board of Trade should be induced to adopt

Holmgren's test. In the *Lancet* for January 13th, 1877, there is a communication "On the Prevalence of Colour-Blindness", by Mr. Herbert W. Page, Surgeon to the London and North-Western Railway Company. Mr. Page believes that this defect of vision is very uncommon. In eight hundred men employed by the Company, he did not find one instance of true colour-blindness. He quotes also the opinions of some other railway surgeons. Mr. Oliver Pemberton of Birmingham says: "My experience is that it is of excessive rareness, and I have examined many hundreds in the course of twenty-five years." Mr. Puzey of Liverpool says: "I have not found it common. Sometimes I have met with it; and sometimes when I have thought I had a case I have found that the fact was merely the man did not know the names of the colours." Mr. Page of Carlisle says: "I have met with only three cases of colour-blindness out of many hundreds whom I have examined.....I have supposed I had a case of colour-blindness before me, when in reality it was nothing more than ignorance of the names of the colours." Mr. Herbert Page does not specify the method, he used in making his investigations, but it is evident from his general remarks that it is some plan by which the individual is called on to give the correct name to a colour placed before him, and I have shown how completely unreliable any such method must be.

It may be said that if a colour-blind railway official or sailor be able to distinguish the red from the green light, it matters little whether he does it by aid of his chromatic sense or by some appearance apart from the colours of the signals. I grant this freely, and I can readily understand a colour-blind engine-driver of many years' standing never being detected in a mistake. Let such a man, however, be driving of a foggy night, or when snow is falling, when even the man with normal colour-sense finds a difficulty in recognising a difference between the signals, and how apt will he be to confound them. It may also be said that the percentage of colour-blind persons is so small that the defect is hardly worth considering from a practical point of view. Fortunately, the percentage is small, but not so small as to be of no practical importance. Upon the Great Southern and Western Railway of Ireland there are about one hundred engine-drivers; and amongst these I venture to say there are three or four who are colour-blind. Surely every train to which these drivers are attached is exposed to a great, an unwarranted, and an unsuspected danger.

I am strongly inclined to suspect that the dangers from colour-blindness are greater at sea than on land. How frequent collisions at sea have become!

ON THE PREVENTION OF SUICIDE.*

By W. F. WADE, F.R.C.P.,

Physician to the General Hospital, Birmingham.

SELF-DESTRUCTION is of all modes of death that which leaves in the hearts of sorrowing survivors the most poignant and the most enduring sting.

From the evidence of Mr. James Wilkes before the Select Committee on Lunacy Law, it appears that, in 1875, one thousand six hundred persons committed suicide in England alone. In the opinion of this same witness, for many years a Commissioner in Lunacy and previously long the able head of a large county asylum, "the great majority of them were probably insane, and they committed suicide for want of proper care". This is a truly shocking statement; the more so, in that it is true. What medical man can carefully read in the daily papers the ever-recurring paragraph headed "Suicide", without acquiescing in Mr. Wilkes's view? Further than this, there can be no doubt that a large number were curable, and would have recovered but for "want of proper care".

In too many cases, there has been not merely a want of *proper* care, but an absence of any care whatever. A man sees his wife day after day moping, neglecting her household duties, formerly assiduously performed; careless of her person and attire, formerly cleanly and neat; muttering to herself in monotonous phrase; not eating, not sleeping. He keeps on going to his work as usual, and returns home one evening to find her drowned in the water-butt, and perhaps one or two of his children with their throats cut. Quite true, he did not expect such a catastrophe; if it could be proved that he had expected it, he would possibly be liable to an indictment for murder. But he erred through ignorance, and consequently receives the commiseration of the coroner and his jury, and perhaps even a small subscription.

But is such ignorance excusable? Day after day, the newspapers

report such cases; and, if people who read them are too careless to draw the proper lesson from such reports, means ought to be taken to teach it to them.

In other cases, the culpability is of a graver type. A doctor has been called in, and, recognising the dangerous situation of the patient, has given wise and suitable advice. This, through prejudice, disbelief, or indifference, has been neglected. We must all of us have found how much of earnest and reiterated solicitation is often required to induce persons having charge of such poor creatures to submit them to proper control even at, but especially away from, home.

I fear it must be admitted that there is yet another class of cases in which we ourselves, and not the public, are to blame: cases in which we have either not recognised the disease with sufficient promptness, or have not insisted on the necessary treatment with adequate urgency. I believe that this class is a small one, and I hope that it is daily decreasing, and will decrease; but as yet we can scarcely with truth deny its existence.

We come now to consider whether their duties are adequately discharged by another class of persons. Do coroners make a sufficiently searching inquiry into cases of suicide in a state of insanity? I have no intention of considering whether or no the evidence in all cases justifies the verdict, but only whether, when this is undoubtedly justified, the investigation ought not to be pursued further than it habitually appears to be. The main object of an inquest is to ascertain whether death has been by fault of any person, either wilfully or maliciously or through negligence; and, if so, by whose fault. It is the duty of the coroner to see that this object is attained. Even in cases where no one is shown to be criminally liable, coroners are accustomed—and, in my judgment, it is a very salutary proceeding—to lecture with severity persons who may be morally, though not legally, guilty of neglect. For example, not long ago a man stood quietly on a canal-bridge and watched a boy drown without making even any pretence of assisting him. He was within his strict legal rights; but the coroner commented with becoming indignation on the fellow's gross and pitiless inhumanity. But, as regards the cases we are discussing, coroners do not, so far as I can see, take such a view of their duty as is likely to lead to any diminution of the lamentable neglect of proper precautions to prevent insane suicide. I say this after having long paid attention to the newspaper reports of such inquests. It is true that such reports are, for the most part, brief and condensed; and that a perusal of the depositions, which are not at our disposal, might show the matter in an entirely different light. On the other hand, newspaper reporters are exceedingly acute in seizing on any items likely to interest the public; and I cannot but think that, if coroners took the same view of their duties in these cases as I do, it would soon appear so plainly in their questions to witnesses and in their charges to juries, that the reporters would not leave it possible for any candid reader to entertain the opinion which I at present hold. A case happened not long ago which illustrates the frame of mind in which even experienced coroners seem to approach these cases. A gentleman either became giddy and fell, or else threw himself, under a locomotive engine. There did not appear to be the least reason for thinking that the engine-driver could by any possibility have averted the catastrophe. Nevertheless, the coroner "cautioned" him before giving his evidence. This was, no doubt, perfectly right and proper, because it might have turned out that the man was to blame. The victim had been for some time under medical treatment. His doctor was called as a witness, but was *not* "cautioned". Now, it is obvious that it might have turned out that he had been guilty of malaproxia in not having ascertained that his patient was suicidal, or, having ascertained that he was, in not having taken due precautions. No member of the family was called with a view of discovering whether he had manifested any suicidal tendency; yet, in the opinion of the engine-driver, who saw the whole transaction and who really had no motive for influencing the verdict, the man had jumped on the line. This case happened before a coroner of long and very large experience, and is mentioned as an example of a coroner failing to realise his public duty in regard to cases of this kind.

Is it too much to say, firstly, that in a large number of cases of insane suicide, somebody is to blame; and, secondly, that no one ever is blamed? It seems to me that the proper course to take, with a view of rectifying the inadequacy of these inquests as at present conducted, is to apply to the Home Secretary. We have not, but he has, access to the only reliable documents; viz., the depositions. We can carry the case no further; he can, and I have no doubt, on due cause shown, will. Let us respectfully request him to cause a careful investigation to be made of the depositions in every case where the verdict is one of "Suicide in a state of temporary insanity", with a view of determining whether due care has been taken to ascertain whether anyone, and, if so, who, has been guilty of negligence in the matter.

* Read in the Section of Psychology at the Annual Meeting of the British Medical Association in Cork, August 1879.