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.*

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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.*

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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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