

the three fundamental sensations, is made only for the sake of greater convenience in discussion.

Indeed there is still much for us to learn regarding the nature of colour sensation. Among the yet unexplained phenomena are those of simultaneous colour contrast. The fact that a small brightly-coloured area on a grey background appears surrounded by its complementary tint is familiar enough. For its explanation it has been common to assume that there is unconscious motion of the observer's eyes, incipient retinal fatigue, an error of judgment, or fluctuation of judgment. This has been tested by A. M. Mayer (*American Journal of Science*, July 1893), who ingeniously devised methods for showing these contrast phenomena on surfaces large enough to match the colours with those of rotating colour discs, and thus to arrive at quantitative statements of their hues. When viewed through a small opening in a revolving disc the subjective contrast colour was unmistakably perceptible when the duration of passage of the opening was less than  $\frac{1}{1000}$  of a second. The same effect was obtained in a dark room with instantaneous illumination of the coloured surface by the strong spark of an electric influence machine. The duration of illumination is thus almost infinitesimal, certainly not more than  $\frac{1}{100000}$  of a second. The hypothesis of fluctuation of judgment is thus shown to be wholly untenable. I have performed most of these experiments, either with Prof. Mayer or separately, and my testimony can therefore be united with his. The case is quite analogous to that of the perception of binocular relief, which was once explained as the product of a judgment, but was found to be always possible with instantaneous illumination. Prof. Mayer has devised a disc photometer based on colour contrast, with which the error of a single reading was found much less than with the Bunsen photometer.

The rotating colour disc has been applied by O. N. Rood (*American Journal of Science*, September 1893) to the determination of luminosity independently of colour, by taking advantage of the flickering appearance on a rotating disc upon which two parts have different reflecting powers. An extreme case of this is that of a white sector upon a black disc. At a certain critical speed the retinal shock due to momentary impression by white light becomes analysed into the subjective impression of spectral colours, the duration of the retinal sensation varying with the wave-length of the incident light. The law of this variation has been studied by Plateau ("Dissertation sur quelques propriétés des impressions produites par la lumière sur l'organe de la vue," Liège, 1829), Nichols (*American Journal of Science*, October 1884), and more recently with much precision by Ferry (*ibid.*, September 1892), who showed that retinal persistence varies inversely as the logarithm of the luminosity. For a given source of light separated into its spectral components, the yellow is the brightest. For this hue accordingly the retinal impression is shortest, and for violet it is longest.

Under appropriate conditions the after-effect on the retina has a certain pulsatory character, as first noted by C. A. Young (*Philosophical Magazine*, vol. xliii. p. 343, 1872) in 1872, and carefully studied within the last few years by Charpentier ("Oscillations rétinienne," *Comptes rendus*, vol. cxiii. p. 147, 1891) in France, and Shelford Bidwell ("On the Recurrent Images following Visual Impressions," *Proc. Royal Society*, March 27, 1894) in England. A disc with properly arranged black and white sectors, if brightly illuminated and looked at while revolving at a moderate rate, becomes apparently coloured, just as a momentary glance at the sun causes the perception of a succession of subjective spectral hues which may last a number of seconds. The phenomenon in relation to the disc was known as early as 1838 (Fechner, *Poggendorff's Annalen*, 1838), and explained by Rood (*American Journal of Science*, September 1860) in 1860. The re-discovery of what has been long forgotten arouses all the interest of novelty. The "artificial spectrum top," devised by Benham (*NATURE*, November 29, 1894, p. 113) last autumn, excited interest on two continents, and was promptly copy righted by a prominent firm of opticians (*ibid.*, March 14, 1895, p. 463) in England. It would perhaps be equally enterprising to copyright the solar spectrum.

The limits of a single address forbid my touching upon the large and practically important subject of colour blindness. Indeed, in both physical and physiological optics much has been omitted that is abundantly worthy of attention. In behalf of my hearers it may be wise to take heed, once more, of the fate of Tarpeia, who was overwhelmed with the abundance of her reward.

### UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Technical Education Board of the London County Council has just awarded 278 minor scholarships, viz. 178 to boys and 100 to girls in Elementary Schools; 334 scholarships of the same class were awarded last spring, upon the results of examination, so that altogether the number awarded by the Board in 1895 was 612.

At a meeting of the Fellows of the Royal College of Surgeons, held on Thursday last in the theatre of the college, a resolution was carried, "that, in the opinion of the Fellows of this college, women should be admitted to the diplomas of the college," forty-seven Fellows voting for the resolution and only ten against. The Fellows alone form the electorate who vote for election to the council, and the effect of this resolution will probably cause the council (who are understood not to be unwilling) to open the examinations to women candidates. At a mixed meeting of Fellows and members, called by the President last November to consider an application from the Dean of the London Medical School for Women for this privilege, Mr. Clement Lucas's proposal to the same effect was negated by the narrow majority of ten in a house of over a hundred.

IN connection with the new Technical Institute recently opened at Wandsworth, the London *Technical Education Gazette* recalls the interesting fact that the first technical school in this country was opened in Wandsworth. The third annual report issued by the Science and Art Department, in 1856, gives an interesting account of this first technical school, which was called the Wandsworth Trade School. The curriculum included partly subjects of general instruction and partly courses of trade instruction classified under three heads, according as they had relation to (1) the building trades, (2) the mechanical and engineering trades, and (3) the chemical and manufacturing trades. The new Technical Institute will, it is hoped, revive the traditions established by the pioneer school of 1856. In addition to an equipment grant of £500, the Technical Education Board has agreed to contribute £1000 to the maintenance of the institute for the current year, apart from any grants which it may make for the maintenance of the technical day school.

### SCIENTIFIC SERIALS.

*Bulletin of the American Mathematical Society*, vol. ii. No. 2, November 1895.—Concerning Jordan's linear groups, is a paper by Prof. E. H. Moore, which was read before the Society in August last. It is a continuation of a paper read in November 1894, entitled "The group of holoedric transformation into itself of a given group" and is an exhaustive one supplemented by numerous bibliographical details.—Prof. A. S. Hathaway presented, at the same meeting in August, an elementary proof of the quaternion associative principle. Hamilton in his "Elements" writes: "The associative principle of multiplication may also be proved without the distributive principle, by certain considerations of rotations of a system, on which we cannot enter here." This note states that it is easy to see that such a proof is possible; but the details of it could not have presented themselves to Hamilton in an elementary form, or he would have seen that it was just the demonstration for which he was looking, simple in character, and direct in its application. We are not sure that we have not seen a proof somewhat similar to the Professor's, but we cannot recall it to our recollection. The proof given is a simple one.—The next article is a paper read at the October meeting of the Society, entitled "Moral Values," by Mr. R. Henderson. The author reminds us that the question of moral values in connection with the theory of probability has given rise to great diversity of opinion among mathematicians, and that Bertrand, in his classical work, dismisses it with contempt. More than the usual space is devoted to the notes and new publications.

*American Meteorological Journal*, December 1895.—Psychrometer studies, by Dr. Nils Ekholm. This article chiefly refers to the peculiar action of the wet-bulb thermometer near the freezing point of water. The author's observations and other investigations show that in an air saturated with water-vapour, the ice-covered bulb reads higher than the water-covered one, which, under those conditions, reads exactly as the dry bulb. These results are explained by Prof. W. Ramsay's experiments, which prove that there is a difference in the tension of water-