blance between them. But neither is it an unlikeness, for a man may strike himself, and since he is then a striker only so far as he is struck, and *vice versa*, it is impossible to say that striker and struck are unlike. In short, the relation is neither a likeness nor an unlikeness, for the reason that both these latter are relations between objects similarly related to one another, while the relation of striker to struck, like most relations, is between dissimilarly related objects.

The few pages we have thus examined are a fair specimen of the strength of the whole book. Its purpose is a sharply-defined one; its style is clear and free from verbiage; and if it is not a striking success, it is because its author is not thoroughly well grounded in his subject.

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ROOD'S CHROMATICS

Modern Chromatics. With Applications to Art and Industry.

By Ogden N. Rood, Professor of Physics in Columbia College. With 130 original illustrations. New York: D. Appleton & Co. 1879.

CSP. identification: Haskell, *Index to* The Nation (the last two paragraphs are by Russell Sturgis, a contributor specializing in topics on art). See also: Burks, *Bibliography*; Fisch and Haskell, *Additions to Cohen's Bibliography*.

Ogden Nicholas Rood (1831-1902) entered Yale in 1848, but transferred to Princeton where he was graduated in 1852. He held the position of professor of physics and chemistry at Troy University from 1858 until 1863, and was professor of physics at Columbia University until his death. His *Modern Chromatics* gained immediate acceptance as the most authoritative text on that subject, and was translated into French, German, and Italian. Rood, known as the "Father of American Experimental Physics," was an extensive contributor to the *American Journal of Science*, and was highly regarded among the scientific community. He was a member of the National Academy of Science, the American Association for the Advancement of Science, and the Century Club of New York.

The utility and significance of visual perceptions distract attention from the mere sensuous delight of color and light; yet few elementary pleasures are so insatiable. The spectrum, however often it may be seen, never ceases to afford the same sense of joy. The prices paid for luminous and colored stones, though exaggerated by fashion, could only be maintained on the solid foundation of a universal pleasure in color and light, together with a sense of similitude between this feeling and those which the contemplation of beauty, youth, and vigor produces. This pleasure makes one of the fascinations of the scientific study of color. Besides this, the curious three-fold character of color which assimilates it to tridimensional space, invites the mathematician to the exercise of his powers. And then there is the psychological phenomenon of a multitude of sensations as unaltered by the operation of the intellect, and as near to the first impression of sense, as any perception which it is in our power to extricate from the complexus of consciousness—these sensations given, too, in endless variety, and yet their whole diversity resulting only from a triple variation of quantity of such a sort that all of them are brought into intelligible relationship with each other; although it is perfectly certain that quantity and relation cannot be objects of sensation, but

are conceptions of the understanding. So that the question presses, What is there, then, in color which is not relative, what difference which is indescribable, and in what way does the pure sense-element enter into its composition?

In view of these different kinds of interest which the scientific study of color possesses, it is not surprising that the pursuit is one which has engaged some of the finest minds which modern physics can boast. The science was founded partly by Newton and partly by Young. It has been pursued in our day by Helmholtz and by Maxwell; and now Professor Rood produces a work so laden with untiring and skilful observation, and so clear and easy to read, that it is plainly destined to remain the classical account of the color-sense for many years to come. Chromatics is to be distinguished from several other sciences which touch the same ground. It is not chemistry, nor the art of treating pigments, nor optics (which deals with light as an undulation, or, at least, as an external reality); nor is it a branch of physiology, which might study the various ways of exciting the sensation of color, as by direct sensation, contrast, fatigue, hallucination, etc.; nor is it the account of the development of the color sense. The problems of chromatics are two: First, to define the relations of the appearances of light to one another; and second, to define their relations to the light which produces them. It is, therefore, a classificatory, not a cause-seeking science. The first series of relations according to which it classifies colors are those of the appearances in themselves. Here we have grey ranging in value from the darkest shade to the white of a cloud. The shades may be conceived as arranged along an axis about which we have circles of color —yellow, red, blue, and green, with their infinite intermediate gradations. Each of these varies in value, and also in its color-intensity, from neutrality at the centre to the most glaring hues at the circumference.

The second series of relations which the science of chromatics considers are those which subsist between the appearance of a mixture of lights and the appearances of its constituents. By a mixture of lights is not meant a mixture of pigments, but the effect of projecting two colors—say, for instance, by two magic-lanterns—upon the same spot. It has been found that for this kind of mixture (although not for the mixture of pigments) the appearance of the mixture is completely determined by the appearances of the constituents, whatever may be the physical constitution of the light of the latter. The effect of mixing two lights is, roughly speaking, similar to that of adding together the sensations produced by the two lights separately. Let, for example, two precisely similar lights be projected on the same spot, and the result will be brighter than either, and in hue and color-intensity nearly like them. If white and blue be thrown together, the result will be a brighter and more whitish blue. Red and blue thrown together will give purple, blue and green will give blue-green, yellow and red will give orange, etc. Unfortunately for the perspicuity of the subject, this approximate equivalence between mixing light and adding together sensations is not precise, nor even very close. On the contrary, the mixture is always less bright and nearer to a certain yellow than the sum of the sensations of the constituents. This yellow, the precise color of which is defined, is one in comparison with which the purest yellow that can be isolated appears whitish. It has been called the *color of bright-*

ness. The most striking example of this effect is afforded by a mixture of red and green, which gives a strong yellow effect, although the sum of the two sensations is nearly white.

The study of mixtures has thus given rise to a system of classifying colors which coincides just nearly enough with that derived from the appearances themselves to be generally confused with it, while it differs from it enough to make such a confusion utterly destructive of clear conceptions of the relationships of color. One of the highest merits of the work of Professor Rood is the avoidance of this confusion; and if, for instance, no distinction is made between complementary colors in the sense of those which, when mixed, give white, and in the sense of those whose sensations sum up to white, it is doubtless because here, as elsewhere in the book, logic and scientific precision have more or less suffered from a determination not to repel indolent minds.

As to the question whether scientific investigation is an aid to artistic production or to artistic judgment, the author seems to assume that it may be. In the preface it is asserted that while knowledge of the laws of color "will not enable people to become artists" it may yet help in artistic work, and still more in the appreciation and criticism of artistic work. Now, whether this is so or not there is no chance to discuss in these columns, but a chapter of Professor Rood's book might well have been devoted to the examination of that question, and we regret to find instead of such examination the whole argument of the last two or three chapters resting upon the assumption of what, we think, ought to have been proved. Should the decorative artist regard or disregard Chevreul's 'Laws of Contrast,' Hay's 'Laws of Harmonious Coloring,' and other such tables and treatises? Our author, we think, would say aye to that question, but nearly all artists who are concerned with color would say no; and the more they know of these theories the less, we think, do designers in color respect them. "Red lead with blue-green gives a strong but disagreeable combination; . . . vermilion with blue gives an excellent combination; . . . vermilion with green gives an inferior combination; . . . sea-green with blue gives bad combinations." There are four pages of such statements, arranged in a tabular form and credited to Chevreul (in whose book there are a plenty more) and to Brücke, and tending to no result, for the qualifying terms "good, . . . bad, . . . strong, . . . excellent, . . . weak" at once overset any claim to scientific accuracy, and no color-designer would try more than once to make practical use of such statements. Our author seems, indeed, to be aware that it is not a scientific method he is following here, for he avows his disagreement with one statement of M. Chevreul, both statement and contradiction being given as mere matters of opinion.

The last chapter is devoted to the use of color in painting and decoration; and in this the evident knowledge and right feeling of the author are made useless by the false system adopted—the system of arguing from assumed principles to results, instead of comparing results together with the view of establishing principles. Many of the assertions as to the difference between "painting," as in pictures representing nature, and decoration; as to the difference between transparent color, as in stained glass, and opaque color seen by reflected light; as to the proper aim and limits of decoration; and as to the proper order of artistic study, will wholly fail to command the adhesion or even the respectful consideration of students of art. And this seems to result wholly from the unfortunate assumption spoken of above—the assumption that the scientific method can be carried beyond the discovery of fact to the laying down of positive laws for practice. "The aims of painting and [of] decorative art are quite divergent" (p. 306). No, but convergent; for, starting from different points, as our author truly says, they reach one and the same result. The objects of the painter of pictures and that of the decorative painter are different; but with different aims they reach the same result, and in all the best work there is in the world there is no saying whether the "painter" or the decorator has been at work.

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NOTES

CSP, identification: Haskell, *Index to* The Nation. See also: Burks, *Bibliography: List of Articles.*

—The current number of the *American Journal of Mathematics*, which is published under the auspices of the Johns Hopkins University, contains an account of a fundamentally new phenomenon in electricity, not explicable by anything hitherto known. The definition of the new action is not yet certainly made out; but it appears to be that if we say that the direction of a galvanic current is from the negative to the positive pole, then a magnet tends to deflect the current within the conductor in the same direction in which it tends to turn the conductor itself. This fact will be a complete surprise to physicists, and its importance to the theory of electricity can hardly be overestimated. The discoverer is Mr. E. H. Hall, assistant in the Laboratory of Professor Rowland, to whose encouragement and assistance the discovery was in a large measure due. It may justly be said that no discovery equally fundamental has been made within the last fifty years. Discoveries so novel have usually been in some degree the result of accident; but in this case elaborate and very delicate experiments were undertaken to ascertain whether or not any such phenomenon could be observed. The new force is exceedingly feeble, so that we cannot predict any practical applications for it.

—The same number of the *Journal* contains several other important papers, including three by the celebrated algebraist Sylvester. All of these afford salient examples "of the importance of the part played by the *faculty of observation* in the discovery of pure mathematical laws." There has been, perhaps, no other great mathematician in whose works this is so continually illustrated as in those of Professor Sylvester. An example of a mathematical proposition known to be true many years before any one succeeded in producing a demonstration of it, is the familiar fact that on any possible map, however complicated, the different countries may be distinguished from those which adjoin them by painting them in only *four* different colors. This has been known for a long time, but the first