HELMHOLTZ AND THE THREE-COLOR THEORY: AN HISTORICAL NOTE

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The historians emphasize Helmholtz's espousal of Thomas Young's
theory of color vision but the fact is Helmholtz was at first none too cer-
tain about the correctness of what we now call the "Young-Helmholtz
theory." Even Boring is wrong in thinking that Helmholtz accepted the
theory with alacrity in 1852. Helmholtz was still slightly dubious of it
as late as 1860, and in 1852 had actually rejected the three-color theory.
The following quotation from his 1852 paper, which was translated and
published in its entirety in the Philosophical Magazine in England during
the same year, clearly shows Helmholtz's position at that time.

Hence, if we propose to ourselves the problem of imitating the colours of the
spectrum by the union of the smallest possible number of simple colours, we find

1 In his most recent volume on the history of experimental psychology (Sensation
and Perception in the History of Experimental Psychology, 1942, 1-63) Boring
makes the following statements concerning Helmholtz's sponsorship of the three-
color theory:

"In 1852, when he first adopted Thomas Young's theory of color, Helm-
holzt posited three specific visual energies" (p. 73).
"Quite early (1852) he brought forth and championed Thomas Young's
theory of color, developing it as a theory of three specific nerve energies" (p.
119).
"Helmholtz (1852) in reviving Young's theory, threw the weight of his
opinion toward three physiological processes, a principle accepted by most
theorizing today as fundamental" (p. 128 f.).
"Helmholtz's theory had held the field after 1852" (p. 173).
"Helmholtz advertised Thomas Young's views and formulated the three-
color theory in 1852. Clerk Maxwell supported Helmholtz" (p. 185).
"Until Helmholtz publicized it (Young's retinal theory of color) in 1852,
however, it attracted scant attention" (p. 199).
"Although Helmholtz's experimental study of complementaries in 1852 is
the first date for his espousal of the theory, the event was marred by Helm-
holtz's failure to find that he could get white from more than one binary com-
bination" (p. 200).

Every one of these statements is in error. Helmholtz may indeed have "brought
forth," "adopted," "championed," "revived," "advertised," "publicized," and "es-
poused" the Young theory, but to state that he did so in 1852 is incorrect. The
"espousal" of the theory, moreover, was not "marred" in 1852 by a minor experi-
mental failure. On the contrary, Helmholtz's experimental results at that time led
him rather to reject the three-color theory.

2 Helmholtz, Ueber die Theorie der zusammengegmetten Farben, Ann. Phys. Chem.,
163, 1852, 45-66, (Ser. 2, v. 87). Also in Arch. Anat. Physiol. u. wiss. Med., 1852,
461-482; and reprinted in his Wissenschaftliche Abhandlungen, 2, 1883, 1-22.
Young view in 1855, had postulated three elementary color sensations of greater saturation than those experienced in viewing the spectrum, and had even suggested a means for obtaining supersaturated color sensations: “It may be possible to experience sensations more pure than those directly produced by the spectrum, first by exhausting the sensibility to one color by protracted gazing and then suddenly turning to its opposite.” In his 1858 paper, Helmholtz reports the experimental production, in just such fashion, of sensations more saturated than the spectral colors, and he observes that their existence is necessary for the Young theory to be correct.

In a short paper, published in 1859, Helmholtz briefly indicates that Young’s theory can be used to reduce the multiplicity of color phenomena to simple principles; he confirms Maxwell’s findings on the color equations of the color blind and suggests an explanation of color blindness in terms of the Young theory; and finally, he sees in the study of the color mixture data of these individuals a means for determining the Grundfarben.

A fuller development of the three-color theory came only in 1860 with the publication of Volume II of the Handbuch der physiologischen Optik. König summarizes the development of, and the changes in, Helmholtz’s position in relation to the theory in the following statement.

The extent to which the recognition of Young’s views was bound up with the advance of experimental results is indicated by the fact that even Helmholtz at first (Pogg. Ann. 87, p. 43 and Müller’s Archiv, 1855, p. 461) believed he saw in the observed facts an incompatibility with these views, while soon afterwards, on the basis of additional investigations, (Verb. des naturhist. med. Vereins zu Heidelberg, 2, 1859, 1; Handbuch der physiol. Optik, 1st edit. Par. 20) he acknowledged Young’s theory completely.¹

Helmholtz’s shift in position with regard to the three-color theory is of interest today, particularly in view of recent experimental developments. A multiple-receptor, or polychromatic color mechanism is suggested by Granit’s work in electrophysiology² and by Hartridge’s microstimulation studies.³ The shift, on the part of a few investigators, away from the

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¹ J. C. Maxwell, On the theory of colours in relation to colour-blindness, in George Wilson’s Researches on Colour-Blindness, 1855, 135-139.
⁶ H. Hartridge, Recent advances in color vision, Science, 1948, (no. 2807), 395-405.
simple three-component and towards some form of polychromatic theory is, ironically enough, a return to Helmholtz's original position. Indeed, one of the arguments used to support a polychromatic view is the very one concerning the desaturation of mixture colors upon which Helmholtz based his original rejection of the Young theory. 14 We may yet find that Helmholtz's original straightforward interpretation is to be taken at face value, and that, rather than accepting the theory of a three-receptor mechanism with its assumption of hypothetical, unreal primaries derived through mathematical treatment of color-mixture data, a more adequate physiological view than has hitherto been presented will be forthcoming to explain all the facts.

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14 Hartridge, op. cit., 397-398.