

**The human color-sense considered as the organic response to natural stimuli / by L. Webster Fox and George M. Gould.**

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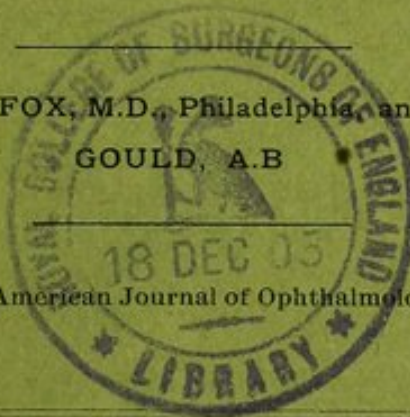
**THE HUMAN COLOR-SENSE CONSIDERED**

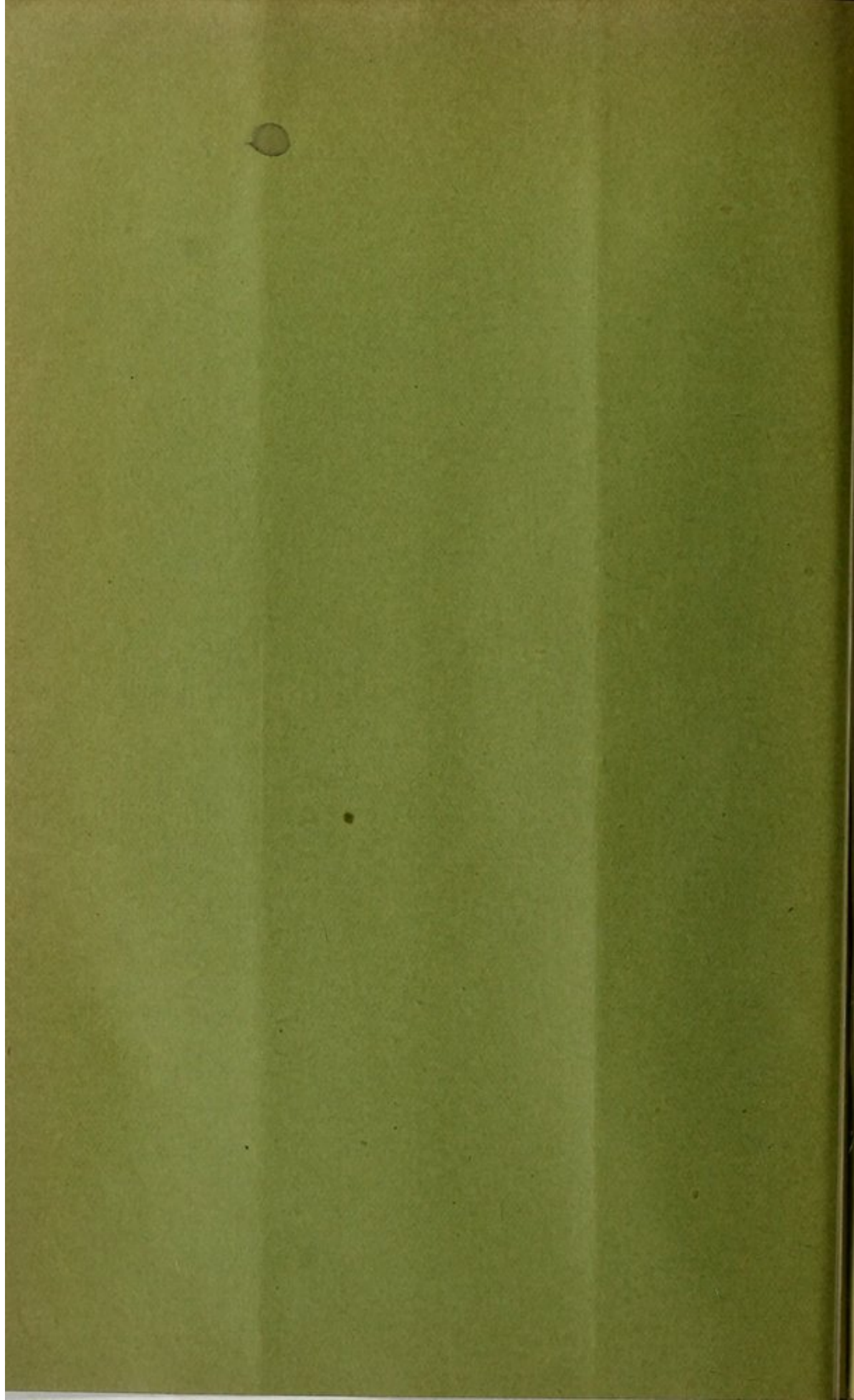
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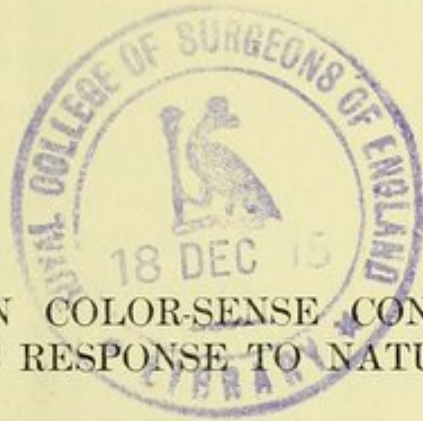
By L. WEBSTER FOX, M.D., Philadelphia, and GEORGE M.  
GOULD, A.B

[Reprint from the American Journal of Ophthalmology, Sept., 1886.]









THE HUMAN COLOR-SENSE, CONSIDERED AS THE  
ORGANIC RESPONSE TO NATURAL STIMULI.

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BY L. WEBSTER FOX, M. D., PHILADELPHIA, AND GEO. M. GOULD, A. B.

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Were one a Comtist student of light and color, he could point to no branch of human knowledge, illustrating, at least so far, more appositely than that of chromatics, his master's three-fold division of the states of science, into "theological, metaphysical and positive." For untold ages men had worshiped the sun, the stars, fire, light, with all degrees of intellectual abjection, or intellectual perfection, from the lowest fetichism of a savage, to the most idealized symbolism of a Dante, before the subtile but simple conception of the undulatory nature of light, or the "metaphysical" explanation, occurred to the mind. Thanks to the labors of many great students and profound thinkers in the past three hundred years, we are now in the clear as to this second stage; the physical causes of vision are quite decisively settled; the causes of ether-waves, the laws of their action and propagation, their measurements and powers, have all been made out, and there is probably little left in this direction to discover. Men's minds therefore turn to the "third stage", and try to show the relations, successions and resemblances of these to other phe-



nomena. But here the Comtist theory meets a check; modern science has advanced the sphere of its activity and work into regions undreamed of, and wholly discountenanced by Comte's scheme. We are not content to study external phenomena *per se*, however wide the relations established. No science of today is content to see forces disappearing behind the Isis-curtain of the mind, and other and transmuted forces reappearing from that veiled sanctuary, without seeking to push aside that curtain, and learn what is the mystery there. So it is that all knowledge has remotely or directly a vital interest in those new methods of research, inaugurated by evolution and controlled by exact science, which we call physiological psychology, or psychiatry. It is found that no study of the relations of diverse phenomena is for a moment complete or satisfactory without psychological phenomena are included. Tyndall enjoins: "The roots of phenomena are imbedded in a region beyond the reach of the senses, and less than the root of the matter will never satisfy the scientific mind." Only by thus extending the scope and extent of the relations of phenomena to those of physiology and psychology can the Comtist's third stage include the recent development of light-studies.

In following along the path of light in its progress toward the brain, it was but natural that the eye should have arrested the attention of students, and that the advance of optical studies should have been stopped till its mechanism and powers had been duly apprehended. Moreover, if the intricacy and marvelousness of its construction be considered, it is all the more natural that, so long as its function remained mysterious, the crux of the whole problem of vision should have been lodged in it. In this way arose the idea of its specific functions, and from Herschell and Newton, to Young, Helmholtz, Hering and Preyer, the retina has been supposed to have a differentiating and specific energy, whereby the phenomena of chromatic sensation were explainable. Gradually, however, it is becoming plain that the retinal end-organs, as well as those of other senses, have no such power; instead of this the retinal function must be held as simply correlating the physical stimuli with the psychic reaction, and without power to create specific differences in the



stimuli received by it. Some of the grounds of this new envisagement of the phenomena are to be found in Wundts' now classical work; other statements of the same necessity are expressed in articles by H. M. Burnett, M. D., in the *American Journal of Medical Sciences* for July, 1884, by C. A. Oliver, A. M., M. D., in the same journal for January, 1885, and by the writers of the present article in the July 1886 number of the AMERICAN JOURNAL OF OPHTHALMOLOGY. We there try to advance a step, and give a nearer answer to the question as to the more intimate nature of the retinal process. We described it as a refined and delicate perception of thermal differences, if not identical, certainly not dissimilar from the function of the peripheral sensory end-organs. The facts of physics and physiology seemed to demand the supposition of a retinal intermediate, vibrating in correspondence with the varying wave-length of the ether, whose kinetic energies it transmutes into its own molecular activity, and the varying degrees or heights of this molecular activity are taken up by the cones and transmitted to the co-ordinating center for reworking into the cerebral products of color and light.

It was thus found that the result of this was to transpose the seat of the difficulty from the retina to the brain. Were we system builders, we might say that the progress of knowledge in regard to vision consists indeed of three stages: physical, physiological and psychical,—the first, in systematizing and formulating the laws of ethereal vibration; the second, in tracing the laws of the transmutation or causal relations of the ether-wave stimuli and the succeeding nerve-message; the third, in explanation of the transmutation of neural vibrations into the sensations of light and color. We have said the problems of the first stage are now answered. The difficulty encountered in the second was greatly increased by what we believe to have been the error of confounding it with the third. With its supposed specific function, the mind's work was given to the eye to do, and in trying to explain how it might do what it never did do, have resulted all the *de haute en bas* theories and illogicalities of ingenious *soi-disant* discoverers.

In the belief that greater clearness has been reached by elimi-



nating the idea of specific activity from the retinal function, and particularly in regarding that function as essentially a refined perception of differences of molecular activity, we may think more justifiable any attempt to attack the mystery in its new home. We therefore purpose offering a few suggestions as to certain aspects of chromatics from the psychical stand-point, hoping to strike more natural lines of cleavage than has happened heretofore.

In order more precisely to make clear the design we have, let us for a moment hark back to our ether waves; this is all the more necessary since we would do away with the color producing agency of the retina, thus more than ever emphasizing the strict psychological nature of color. *En passant* remarked, it is a rather strange fact how little it has entered the popular imagination that no such thing as color exists outside of the mind. The writer shall not soon cease to regret his temerity in stating this fact to a college graduate and bank president not long since. The remark was met by the silence of dignity, but the ill concealed look of scorn and disgust thinly veiled my friend's thorough belief that I was a fool, or took him for one, in thus trying to guy him with such absurdities.

In a very few people there is a sort of vague compromise in a misty idea that the *eye* may have a little to do with the process, but in attempting to pull this poor support from under them, they would, like the banker, fly to "non-existent objectivity," rather than float in the thin air of "subjective certainty."

In the visible (interference) spectrum we have spread out before our eyes a band of ether waves, differing from each other only in their length and in the corresponding frequencies of their arrival. The wave-lengths, gradually, and without any breaks, vary from .00007604 cm. to .00003933 cm., while the frequencies extend in the same graduated way from about 395 to 764 millions of millions per second. We know that in these facts alone consist all the differences there are out there; color and light do not yet exist—that is, if a blind person could feel these taps separately upon his finger-ends, and count them, he would then know the sum total of the external phenomena. What we wish to call particular attention to is the unbroken



continuity and gradualness of change in this wave-scale. There are no great jumps from waves of one frequency to those of another above, but each glides gradually, and by slow changes into a frequency not greatly different from itself. But when the mind directs the eye to this band, an inconsequential result appears in consciousness. The spectral colors are not a continuously and imperceptibly changing ascent, but consists of a few large steps, or bands of colors, more or less perfectly marked off from each other by delimiting intermediate shades. Within the same color step whose hue seems in all parts identical to the eye, the waves differ often by so much as from five to ten, or even more, millions of millions of vibrations per second. At other points several different tints, or even perfectly defined colors, are caused by no greater different vibrational periods. Again, certain of these colors have been called primary or elementary; but why they have any such a quality, and why the spaces they occupy are relatively so great, and so different in extent as they are—these, with others to follow, are questions we have never heard asked, and so, of course, have never seen any attempts to answer. Yet these are the very queries that arise unbidden in the mind upon looking at this mysterious chromatic ribbon.

Sunlight, we are told, is composed of the following parts:

54.....	Red
140.....	Orange-red
80.....	Orange
114.....	Orange-yellow
54.....	Yellow
206.....	Greenish-yellow
121.....	Yellowish-green
134.....	Green and Blue-green
32.....	Cyan-blue
40.....	Cyan
20.....	Ultra-marine and blue-violet
5.....	Violet

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Condensing the intermediates with the principals we have:

Red colors.....	194
Golden colors.....	454
Green colors.....	255
Blue colors.....	97

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We have an instinctive tendency to compare the color band



or scale with the musical scale; but when we do so we are landed in a maze of difficulties. We realize in sound a higher and lower, a logical connection, order and uniformity of intermediate steps. We are, therefore, bewildered to find, as we do, that there is nothing compared to this in color. There is no up or down, high or low; there is no octave, not even a completed circle; the intensity of sensation does not follow wave-length or even luminous intensity. The maximum of luminosity is in yellow between D and E, but green, a comparatively dark and cold color to the imagination, is not vastly less luminous, while it is far more so than red, which, of all colors, stands out most vividly to the mind's eye. We are perplexed to find no law or reason governing the position, extent, or psychological characteristics of colors.

We think we shall find that much of our amazement and inability to see law and reason in the phenomena arises:

1. From our inattention to the history of the physical stimuli of the eye, to the relative quantities and persistencies of the great classes into which ether waves may be divided, according to the natural objects from which they have, in all past time, been reflected into the eye; and,

2. From our inattention to the psychological history of vision, the psychical origin of color, and the influence of the mind and feelings upon color phenomena and perception.

History, then, is our hunting-ground, evolution our falcon, and the quarry we seek is answers to these questions:

1. The reason why certain colors are called primary or elementary?

2. Why the relative amounts of the primary colors vary as they do in the (normal) spectrum?

3. The explanation of the differences in the objective or luminous intensities of colors?

4. The reason of the differences in their subjective intensities and qualities?

We wish the reader to suppose himself never to have seen or heard of a spectrum, or a theory of color-perception; we know he is a cultivated nineteenth century gentleman, well acquainted with history, especially of primitive man and religions, and well



versed in Darwinian principles. We can assuredly congratulate him, both upon his ignorance and upon his knowledge! If we ask him what great color-classes of visible objects have most occupied man's eye and mind in all past history, we are certain his answer (after as much reflection, *parbleu*, as we ourselves have given it) will be something like the following:

The first in overwhelming importance is light and fire; the second, the world of vegetation; the third would be blood, as the concrete representative of war and struggle, and superstitious symbol; the fourth, the sky above with its reflection in the waters of the earth. It would be difficult to name another class, for whatever other colors nature may have presented to the eye of historic man, they must have been mixtures of these, or unimportant exceptions that have left only a small and inconsiderable organic response in the psychic mechanism.

Let us briefly emphasize and differentiate these four classes of stimuli a little more closely:

1. LIGHT AND FIRE.—It has been said that stimuli of achromatic light are responded to by the infant before those of color, whence, if true, it would be rightly argued that achromatic vision preceded chromatic in the life-history of the animal kingdom. The absence of cones in many animals points to the same conclusion. Perceptions of differences of luminous intensity, as we know from the facts of color-blindness, may still give such animals much of the advantages we derive from color sensations. We allude to the matter here as of importance in showing the probable priority in time, as well as the past and present preponderance of the amount, of such sensations over those of others. With these we class the yellow and orange colors, begging the scientific reader not to start back in disgust, but to consider the following facts: The ordinary suffused daylight, even of a clear day, is slightly yellowish, and in almost all degrees of obscuration of the sun, the more refrangible rays being cut off, the indifference-point of the spectrum is sent farther down into the yellow band. Whether from a greater turbidity of the atmosphere, or increase in thickness of the several mile deep dust-shell always present over the earth, or from the morning and evening obliquity of the sun's rays, much of the *day* of



average humanity has been more yellowish than they perhaps mistrusted. This, it is probable, was more pronouncedly the case in the earlier stages of the world's life. Moreover, the rising and setting of the sun have always flooded the earth for one or two hours each day with a glory of orange or golden radiance. It is also certain that our earthly fires are of a ruddy, golden or yellowish hue, and the scholar of mythology and early religions, knows well enough the part fire has played as a representative of the unseen divine life, or as an homologue of the recurrent changes of the lights of the sky by day or by night. "Pyrolatry," says a life-long student and historian of ethnic religions, "is common to all religions." "Through the whole history of Aryan faith runs the fire symbolism of Mithra." "Jahveh was originally one of those sun-gods in whom all Semitic worship was wont to centre." Quotation from a thousand sources could be added, all of the same import. We all know the beautiful myth of Prometheus and the stolen fire. Ever since man's dawning intelligence caught a glimpse of the mystery of light, of the wonder of the strange lurid glow of the sun at eventide—nay, even back to the time when, by its aid, he cooked the flesh of the animal whose blood he had shed, the wonder of fire was daily and hourly before and in his eyes. Further reason for including the daylight, the sun-shine and the fire hues under the general term golden, comes from the symbolism of gold itself, which, in all ancient faiths, as well as in the instinctive feeling of the modern artist and poet, is the representative metal and color of the divine glory and halo. Perhaps it would not be unwise to say that gold is now the standard of all values, and held to be the loveliest of metals, because it was once the symbol of all light and the ornament of the divine image.

To this consensus of reasons might be added the comparative absence of whites in nature. Clouds are sometimes a dull or grayish white, and snows, however considerable in some countries, are certainly the world over, a small and short-lived covering of the earth's surface. Wherever white sunlight falls on land or tree or rock, it is always reduced to colors by the unequal absorption and reflection following; these colored reflections are the eyes' customary stimuli. When sunlight falls on



the sea only a small portion of the surface reflects white back to the few eyes there or thereabouts. So that as a fact white sunlight is generally reduced to yellowish tints, or other shades before it reaches the eye. Where this is not the case, the rays are too powerful, and producing unpleasant effects upon the eye, are avoided.

The closeness of the relationship between white and golden light is also shown by the ease with which spectral yellow, by increase of illumination, passes over into white, being, as it is, the nearest of all colors to the luminous intensity of that compound. Consequently a complementary color of the lower kinetic value is all that is required to quickly heighten it into the white to which it is so closely allied.

The proportion of the spectral golden rays, 454, or nearly half of the whole, represents the overwhelming part the lights of day and of fire have played in the world's history. The unity of character running through this vast space of the spectrum, testifies to the unity of the cause, and to its power both physically and mentally.

II. THE VEGETABLE WORLD—whose greens have taken up the next greatest portion of the spectral rays—representing one-fourth of the whole—is so plainly the origin of the green band of the spectrum that it is unnecessary to go into detail concerning it. When eyes appeared, next after the golden light of day, they would certainly fall upon some of earth's verdure, and except to the city-man, the proportion holds up to to-day. Green is philologically the growing thing, and grass or tree covers the face of the earth.

RED, occupies the next lower degree in the proportion of the spectral waves. The crimson of the fruit man ate, or of the wine he drank, the deeper orange hues of the flame-points or embers of his hearth-fire, the autumnal reds of the forest trees, or the expansive glory of an occasional scarlet sunset, would not, all combined, account for the proportion of space it occupies, and are infinitely far from explaining the intense and distinctive character of the subjective sensation of spectral red. It can only be explained by the role war and blood-shed, blood sacraments and rites, have acted in the history of the race from



man's egress out of animalism and *progress* to nineteenth century militarism. The blood is the life; and life, so far in our planet's history, has been a perpetual *bellum omnium contra omnes*. Nature herself, as our great Christian poet declares, is red with tooth and claw, while the condition of all savage races *now*, show that it was always so with our own ancestors. A curious and deeply instructive book has lately been published, *The Blood Covenant*, by Trumbull, in this only, and so far as our knowledge goes, can one learn something of the influence of the vision of blood-shedding in the early world. It is an instructive though ghastly picture, that, despite the author's sympathy and sanction, makes one shudder. Strange insights, these, into human nature, which we gain in reading of the blood-drinking, blood-bathing, blood-ransoming, blood-unions, blood-compacts and friendships, blood-sacrifices, and blood suppers, blood burials, blood cures and sprinklings, bloody hands and uplifted arms, blood transfusions, human sacrifices and cannibalisms, bloody burnt-offerings, blood-stained ark of the covenant, bloody passovers and blood atonements! And all this in times of peace! What an echo of long ages when blood shed was no mimicry! The bloody idea is certainly "nail'd wi' scriptur." This is all legend and myth; when authentic history begins, it writes of the sword and red-handed death; the record rolls on with the tired centuries depicting one monotonous tale of sanguinary strife. "War is the matter which fills all history," says a great historian. One million nine hundred and forty-eight thousand lives lost in the last twenty-five years in European battles, and twelve billions of dollars worse than wasted, is the last record, with Europe a huge camp to-day. We spare the reader further quotation and detail we had prepared.

IV. THE PROPORTION OF SPECTRAL BLUE is small in extent and weak in power; it has a character of distance and impersonality exactly corresponding to the sources whence this color has reached the eye. The sky is above, but man's eyes are seldom raised to it. At the horizon it often fades to the violet in which the spectrum likewise passes out of sight.

*Rassemblons nos faits pour nous donner des idées.*

1. In answer to the first query we started out to solve, cer-



tain colors are called primary or elementary, because they have been derived from these great divisions of natural objects we have reviewed. They have been the uninterrupted stimuli of the visual function, since the brain sent its retinal servant out to the body's surface to see by its aid. Some are, if we may so speak, more "elementary" than others, in the sense that some stimuli have been either more prevalent, more powerful or more vitally interesting than others. This is overwhelmingly so of red and gold. In Swinburne's Poems and Ballads, Mr. Grant Allen found the red epithets numbered 159, the gold 143, the green 86, and the blue 25. In Tennyson's Princess the same proportions were 20, 28, 5, 1; and it was so in other cases.

2. A *color* of the spectrum occupies just that amount of space, or, to put it in another way, waves of more or less extended differences of length are perceived as a single color, just as the bulk of the waves from each of these classes of objects have been most uniformly and persistently reflected into the eye during the growth of the race. Nature has acted upon the organism in these continuous ways, and the cerebral product is the spectral colors, in the proportions, and with the characteristics, we find appearing in consciousness. The largest and most persistent stimulus has been that of the gold rays—the varied shades of the diffused light of day, or the ever-present mystery of fire. These have been poured in profusion into all eyes, comprising nearly one-half of their total stimulus, while the green rays make up a fourth, the red less than a fourth, and the blue a still more limited amount.

3. It is a remarkable fact that the objective luminous power follows the same law, and is not caused as we might *a priori* suppose, by the wave-length. According to the latest measurements, by Messieurs Macé and Nikati, the following are the relative luminous powers of the wave systems corresponding to the wave-length first given, the highest power, corresponding to wave-length 569 mm. millionths being given as unity:

$$\frac{681}{0.015} \quad \frac{656}{.080} \quad \frac{641}{.111} \quad \frac{613}{.252} \quad \frac{589}{.788} \quad \frac{569}{1.000} \quad \frac{550}{.954} \quad \frac{534}{.512} \quad \frac{527}{.400} \quad \frac{520}{.314} \quad \frac{507}{.128}.$$

In order to reach the same result of visual acuity, as in the 569 rays, the quantity of light of red, had to be increased



sixty-six times, of green three times, of blue eighteen times, of extreme violet 5460 times.

The explanation of these figures will be found to lie in the physiology of the retina. The stronger waves do not, as we see, produce the most powerful effect; indeed, the luminous intensities have no relations with refrangibility, but seem to depend on facts of another order, which consist in utilizing the residue of rays left over after the absorptions of natural bodies have been satisfied. The greater the wave-length the more wholly such are absorbed, until the line of the descending curve dips pretty low down in red or orange, when the residue becomes so great that the light-curve takes its swift rise, to fall gradually from its crest in  $D\frac{1}{2}E$ , to the extreme end of the visible spectrum, where the dispersive forces of atmospheric refraction allow few of the more refrangible rays to pass to the eye. So the retina has learned to react, not to the most powerful, or to the finest, but to the most continuous and steady stimuli. Its response, therefore, is more perfect to the gold rays, next to the green, lastly to the red and the blue, as Macé and Nikati have found.

4. But there has been a great failure to differentiate the objective from the subjective intensity. Confounding these wholly different phases, has resulted in the *non sequitur* of Magnus and Gladstone, who think red was the first of the colors historically developed. To this we shall return later. Color being a creation of the mind, and after a double transmutation of forces, it follows that its subjective character, may, in part, be independent of objective causes, or direct stimulation, — may be a complex whose elements are by no means all gained through the retina or the visual mechanism. A thousand facts prove, that of all the senses, vision is the most freed from the bonds of logical and necessary connection with the primary sources of stimulation. No fact is more strikingly characteristic of this law than these differences between the objective and subjective intensities of colors. As we have just seen, the order of the former is the highest in gold, falling then to green, red, blue; the order of the second is red, golden, green, blue; and precisely this order tallies with that of the vital and personal



connection with man's life of the four classes of natural objects we have named. The mordant acids of life's needs and passions have eaten these tones deeply, or less deeply into man's brain, according as they have in varying degrees been associated with his miseries and gratifications. Only on this principle can the vivid and powerful effect of red be explained. If private and public blood shed, if social and religious blood covenants, all of which have always been bound up with every day of humanity's advance, — if these would not have bitten into his being an intensity of response unapproached by all other chromatic stimuli, then, the laws of reaction and association taught by scientific evolutionists are empty of force and void of truth. In the language of physiological psychology, this fact might, perhaps, be expressed as the demand for more numerous connections with other cortical centers corresponding to the variety of interest the stimulus excites in them, and the power required in co-ordinating the multitudinous waves of emotion called forth.

The most valuable thing to a man, is of course, his life, symbolized forever, in fact and in covenant, in rite and in ceremony, by his blood. Next to this comes the light of day and of fire, which he has always represented to his mind, as it has been to his eye, of a golden hue, under which term may be accurately grouped the changing effects of the ruddy, orange, or yellowish whites, of light and fire.

Among earth's vegetation man has, of course, built his home ; but there is in the subjective green a lack of power and intensity exactly corresponding to the nature of our impersonal and semi-independent relations to the verdure and growing things about us. In blue these qualities are exaggerated into the feeling of distance and coldness and elevation, derived, of course, from the far away mystery of the sea and sky.

THE INTERMEDIATE COLORS OF THE SPECTRUM should be considered for a moment. The fact of their existence is almost forgotten by color students. This neglect is all the more remarkable when we observe their amazing extent. While each pure "primary" color comprises from forty to eighty parts, we find the mixed intermediates stretching out to 140 between



orange and red, to 114 between orange and yellow, and to 327 between yellow and green! Strictly speaking, these are just as "primary" as the other shades we call red, or yellow, or green. The whole nomenclature is relative, a mere thing of custom. If simple spectral space occupied, or, if the proportions these intermediates bear to the whole number of rays, were decisive, the small spaces of the purer colors would serve as the unnamed delimiting lines for the other and larger stretches and quantities. The extent of these spaces shows us how differing nature's "colors" are from those of the mind, or rather, what receptacles and constructions the mind puts upon the color-intimations or hints of nature. Nature's colors are always broken and mixed; the spectrum gives us homogeneous wave-systems, sorted out of the compound, and arranged seriatim. The prism brings order out of chaos, whilst the mind still further idealizes and reconstructs for itself another world out of the spectrum, by ignoring the mixed intermediates, and emphasizing the small spaces more pleasing to it. But, keeping close to nature, we must ask concerning the significance of the extensiveness of these spaces. This can only lie in the fact that nature's colors are not saturated (from homogenous wave-systems of maximum strengths, but are always from mixed wave-systems, culminating in a higher average of those of one of the four primary colors in each of the four classes of phenomena mentioned. The ocean swell may be made up of many lesser crests and troughs, but there is always one point where the general variations reach their maximum, and this would correspond to the narrow limits of the *pure* color. But between these crests are large regions of indeterminate mixture. Between the pure hues of the deep autumn reds, and the paler yellows, and beyond the rapid instants of ruddy flames and setting suns, are the multitude of ever changing tints of brighter glows, which account for the 140 parts between spectral red and orange. In a like manner we perceive the rationale of the 114 parts between orange and yellow, whilst the protean changes and mixtures of the ever-varying light playing amongst the myriad tinted shadows of the infinite variety of vegetable forms, produces the enormous interspace represented by the



327 intermediate parts, between the yellow and the green of the spectrum.

It will be seen that our endeavor has been to institute a correspondence between luminous stimuli from the natural world, and the chromatic effects of the spectrum's analysis, upon the mind. In all text books and expositions of chromatic and prismatic phenomena, the facts are placed before the awe-struck mind of the beholder without a word more explanation than nature herself vouchsafes. "Beauty is its own excuse for being." The colors, forsooth, are produced by the varying wave-lengths; but why the order, why the quantities, why the amounts, and a thousand other whys—these have always been starting up in the mind of the cause-seeking student. His answer has been the old one given to little Peterkin, when he wanted to know "what was it all about." We indulge the hope that by some such method as we have tried to strike out in this crude fashion, the answers must be finally found. Our color sense must be the organism's response and reaction under stimulus; in a word, it must be investigated by the methods of study which evolution has taught us to use with such brilliant results, in all other departments of biology. The hand of a man, the wing of a bat, the dog's fore-foot, and the horses' fore leg, the bird's wing and the seal's paddle—these are all modifications of one structure, according to the work to be done, and in response to the peculiar stimulus; just so the cerebral products of multiform color-stimuli have left their psychical analogues in our own complex color-sense. The historical and comparative method must likewise be adopted here. For two thousand years psychology hardly advanced a step, because it only interrogated the single and then present mind. Deductive and *a priori* cloud-capping systems of metaphysics and speculation ended in Hegelian Quixotism, and "subjective camels" of strange morphology. Survival of the fittest and comparative methods put an end to all that, and it may be hoped that the same historical method will unravel chromatological problems which have, as we have seen, not been even stated so far.

To a genial and enthusiastic populariser of the evolution phil-



osophy is due the honor of the first tentative effort in this direction. Mr. Grant Allen, (*The Color-Sense*), sought to explain our color-sense through its development, at first, in insects, seeking the nectar of flowers, and also in frugivorous animals, by spying out colored fruits. The book is inherently interesting and valuable; the theory is good enough so far as it carries, but it is not to be forgotten that the flowers are the absolute creations of the eyes, and not the eyes of the flowers; it is hard to escape from the logic which demands a pre-existent color sense of some kind before flower and fruit could utilize the owners of eyes as their messengers and express-agents. Apart from this, we are, if at all, certainly *very* remote descendants of insects, and are quite far away from the birds and such frugivorous folk.<sup>1</sup> It remains to us a marvel of oversight, a curious instance of *idée fixe*, that the great sweep of the mighty forces we have tried to hint at as causally operative in forming our color-sense, should have escaped the gaze of this writer, otherwise so keen of sight on the evolution trail. To have credited these two influences, which, however real and operative in their limited field, were yet trivial and comparatively of little reach, with the construction and organization of our widely complex chromatic sense is a fatal illogicality. He should have taken to heart his own noble and true saying, that, "Evolution forever impresses upon us the lesson that if we would be good philosophers, we must forget our philosophy."

We may in passing allude to the discussion concerning

THE HISTORICAL ORIGIN OF THE COLOR-SENSE.—Gladstone as a Homer-student, and on simple philological evidence, tried to show that "they who fought at Troy" were as blind to certain colors as Homer himself (supposably) was to all. Dr. Magnus, in Germany, drew the same conclusion from a wider sweeping

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<sup>1</sup> As to reasoning concerning the subjective quality, or character of the sensations of color in animals, it must for the present be pronounced out of the question. The subjective expression of the stimulus can only be compared in beings whose minds and psychological histories have been the same or similar to our own. The character of red, e. g., to the animal, as to us, must depend upon the connection of "red" things to the past history of his race.



of word-lore. The whole affair was a dismal collapse, and Allen pricks the bubble with justifiable satisfaction. It was hardly to be expected that if ants, bees and birds had such highly developed chromatic powers, even savage men should be so far behind them. Present day barbarians have essentially the same power in this respect as ourselves, though extreme delicacy of perception is, to be sure, not so highly developed, and their nomenclature would of course be very faulty or deficient, as Gladstone and Magnus might have supposed. The savages' delight in color, as shown in tattooing, and decorating his body, presupposes the ability to feel the differences in color quite as accurately as the birds, whose bright plumage he adorns himself with, and who have no words for colors either. The development of color perception lies far back of all this, and is as old as hunger, in satisfying which, and by the attacks and escapes of enemies, it quite certainly took its rise. The sobering remark of Wallace is also *a propos*, that it is the absence of color that would require accounting for; he says that the most conspicuous pigeons, whether by their color or by their crests, are all found where they have fewest enemies. There seems, indeed, to be an exuberant energy in all organized things, which is only kept from developing variations, and ornaments, and bright colors, by the necessity they are all under of escaping pursuit or hoarding their powers. So it may at last turn out that animals are as bright and beautiful as they can be, consistent with the more important law of self-preservation.

The fact that in  $\frac{9}{100}$  of all color blindness, perception of red seems to be the deficient power, would imply that it were the latest, instead of the earliest acquirement, as has been held.<sup>1</sup>

<sup>1</sup> A great support of the Hering theory lies in the bipolar nature of color-blindness, red-blindness being always, or generally associated with green-blindness. But if red be thrown out of the complex of elements making white, by some unexplained pathological condition, the resulting unity of white, the indifference-point of the spectrum, is moved forward into the green space, and the neutral indeterminate we call white, supplants the green sensation. By a musical note, continuously sounded, the ear becomes incapable of hearing that note; silence results; so, blue glasses, continually worn, destroy the possibility of perceiving blue. In this way the transparent or invisible nature of the indeterminate compound we call day-light white, is explainable, and the similar extinction of green, when red is thrown out of the compound. In total color-blindness, blue sensations are wanting from the same reason, that the indifference-point is removed to the place usually occupied by blue.



The delight of children and savages in red, and the coarse æsthetic sense, might in part, be explainable in the same way, but more accurately and perfectly by the subjective vividness and associations resulting from numberless centuries of blood-covenants and blood-shed. Red is the color of war; savages tattoo themselves with it to arouse their own blood-thirsty instincts, and to strike terror into the hearts of their enemies. That the prevalence of red pigments in nature, the ease of procuring the ochreous earths, and the relative difficulty of getting other pigment colors, would explain the savage predilection for red, is perhaps a slight coign of vantage, but it remains still an example of the triviality of the arguments to which theorizers have been driven. In continuance of the same symbolism as the bedaubed Indian gives to red, it has continued till to-day as the color *par excellence* of military uniforms. The delight in it by the crude æsthetic sense flows naturally from the ages of history when bravery and courage were in man almost the only, certainly the highest of all qualities.

THE ÆSTHETIC SYMBOLISM OF COLOR. — In accordance with our conceptions of the origins of our color-sense, there should be a natural association and symbolism of the different colors with the great classes of our emotional states. If man himself is the concrete result of cycles of permanent reaction between organism and environment, then his visual sense must find its ultimate explanations in the same process, and, like them, look forward to extension and perfection, on the same lines as its development has followed. Now, upon looking within, it is not a little startling to find the great divisions of our psychological nature corresponding with the great associations and divisions of our color-sense. It would be still more striking, if we were not now partially aware of the role color has played in history and in the development of the mind. All objective existences are perhaps more vividly represented to the imagination as colored things, than in any other way, and their associations

- with the woes and joys of life point to no fanciful symbolism, but one which is quite as real and vital as the emotions whence he draws his mental life. Classifying the directions and methods of mental activities, we find them to fall naturally into four classes : —



1. Those of the Passions, — the emotions pertaining characteristically to the sensual life ;
2. Those of the Intellect or Reason ;
3. Those of Utility and Labor ;
4. Those of his Spiritual, Moral and Religious Nature.

These we find to correspond in an exact and specifically real sense with the four analogues of the chief colors previously set forth. Blood is the life, — the nearest, most precious, and vivid of all things or thoughts. Golden light is next in its necessity and nearness to our daily life ; of green we are somewhat more independent, while blue is far away and beyond the reach of our earthly cares and wants.

The symbolisms of red are, therefore, perforce, those of the two great factors of history, War and Love.<sup>1</sup> That only the homologues of the rigorous challenge of red.

In the same definite way the symbols of golden light apply as fittingly and restrictedly to the light of reason and intellect which, flowing over and through all the world's ways, alone promises that clearness of vision by which we can walk in the labyrinthine ways of crowding passions, necessities and duties.

But it is in the world of earth's verdure that man's daily life is cast, and among which he builds his home. This, with its cultivation and shade, its fruitage and various sustenance gives him occupation and rest, food and contentment. So in our psychological analogies, green may stand as the every-day color of general back-ground, of labor, of use, of home-life, peace and rest.

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1 Hargraves Jennings and his Rosicrucians would find a not unjustifiable connection between love and a "blood-covenant," which at recurrent lunations has emphasized the underlying unity of these two great passions, before the phallic worship at the roots of all primitive faiths had passed into multitudinous rite and symbol.

brave *had* the fair, is much truer than that only they *deserved* the fair. The passions, therefore, which stir the blood and heart of men to action, the emotions of honor, vengeance, valor, love, friendship, protection,<sup>2</sup> etc., etc., — these are the fitting

2 Reference to Trumbull's book must again be made for clearer explanation of the words.



Lastly, how appositely blue represents the spiritual life of duty and religion! Blue, derived from the changeless deeps of the arching sky, — overcast, perhaps, for a time, by the passing clouds or mists of mundane change and chance, but always still there, the same forever, the same by day or by night, distant and yet constantly watching over us, impersonal, yet ever in touch with our strongest passions and humblest utilities.

