THE COLOR OF THE SKIN AS ANALYZED BY SPECTRO-PHOTOMETRIC METHODS

II. The Rôle of Pigmentation[1]

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The color of the skin of human beings depends chiefly on the presence of pigment and superficial blood. Spectrophotometric data on the reflection of visible light from the surface of the skin were obtained in a number of subjects possessing various degrees of pigmentation. Analysis of the spectrophotometric curves obtained for normal and pathologic subjects into terms of red, green and violet excitation color values, and subsequent conversion of these values into expressions of dominant wavelength, purity and relative luminosity, indicate certain fairly constant relations of content of pigment to the color of the skin.

Certain secondary factors contributing to the amount of light reflected from the skin, such as surface dirt, oil and moisture, were eliminated by making reasonably sure that the area under investigation was clean. Preliminary readings apparently showed that the presence of a small amount of hair or the obliteration of the normal rugae of the surface of the skin did not affect the percentage of light reflected to any considerable extent. Only under pathologic conditions, involving especially the presence of an abundance of scales, were the reflection values materially altered. It may be said in general that the local contour may be disregarded as a factor in affecting the color of the skin.

[1] The material in this paper was submitted by Dr. Brunsting to the faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Master of Science in Dermatology and Syphilology, 1929. Work done in the Division of Physics and Biophysical Research.

Schultze (4) attempted an analysis of the utilization of light by the skin as manifested by its spectral reflection and transmission. He used a photographic-photometric method of recording the light reflected by the skin, further analyzed the results by means of a Marten's polarization photometer, and plotted the curves in percentages of reflected light. The results of Schultze give information regarding the total reflection of visible light by the skin in various areas of the body under controlled conditions. Although the results do not embody a monochromatic analysis of the reflected light, they show that pigmentation tends to diminish the amount of light reflected by the skin.

Dorno (2), using similar methods, observed variations in the reflection of light by the skin as affected by race, age and sex. He likewise noted general diminution of the light reflected under conditions of increased pigmentation.

Sonne (8) estimated that the skin of a normal person was capable of reflecting approximately 35 per cent of the visible light falling on it.

Sheard (5), and Sheard and Brown (6) were among the first to apply spectrophotometric methods to clinical medicine in a series of observations on the color of the skin in various normal and pathologic conditions, and were probably the first to analyze the resultant spectrophotometric reflection curves into percentages of fundamental red, green and violet excitation color values, dominant wavelength and saturation. The series of investigations reported here is essentially a continuation of their work.

The direct-reading spectrophotometer, known as the Keuffel (3) and Esser color analyzer, with the author's water-cell modification (1), was used throughout these investigations. The cleaned surface of skin was brought flush against one aperture of the water-cooled cell, with constant conditions of temperature and pressure. Readings were made directly in terms of the percentage of light reflected from the surface.

In order to evaluate the rôle of pigment as a factor in contributing color to the skin, comparative records were obtained on subjects presenting varying gradations of pigmentation under normal and abnormal conditions. The following distinctions were observed: (1) variations over several areas of the body of the same subject; (2)

variations among different subjects classified according to type, as blond or brunet; (3) variations in subjects of different races, including the so-called white, black, yellow and red races; (4) a comparison of normal values with the data obtained for subjects manifesting abnormal degrees of pigmentation, such as in Addison's disease, arsenism, argyria and jaundice.

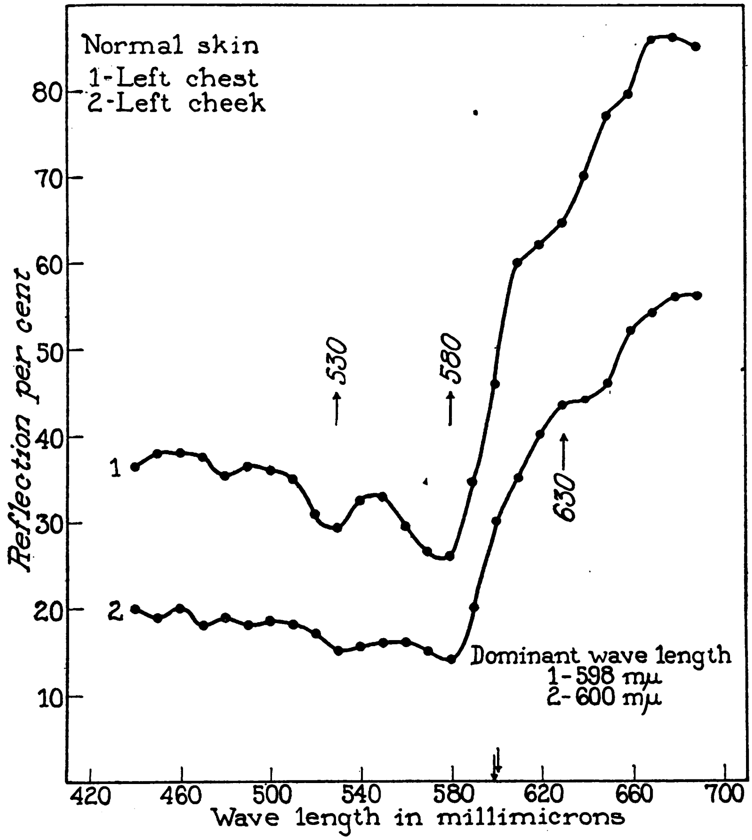

FIG. 1. SPECTROPHOTOMETRIC REFLECTION CURVES OF THE SKIN OF A NORMAL SUBJECT: *1*, CHEST; *2*, CHEEK

VARIATION IN PIGMENTATION IN THE SAME SUBJECT

It is self-evident that the normal skin presents an amount of pigment roughly proportional to the amount of habitual exposure to the sun and the elements. There is a wide variation in pigmentary response in the same subject, as well as in different subjects, to exposure to sunlight.

Figure 1 represents two curves from the same subject showing a record of the light reflected from the skin of the cheek as compared with the chest. In general form the curves are similar; that is, they maintain a similar linear relationship. However, there is a constant difference in the percentage of light reflected throughout the visible spectrum, more being reflected from the chest (which is ordinarily protected from sunlight, as in this instance) than from the cheek, which is more or less exposed. This difference in the amount of reflection represents a distinction in relative luminosity or brilliance of the areas under consideration. The curves show decreased percentages of reflection at the regions corresponding, approximately, to 540, 580 and 630 millimicrons, respectively. That these are related to the presence of superficial blood seems likely, as stated by Sheard and Brown (6); absorption at 540 and 580 millimicrons is due to oxyhemoglobin and at 630 millimicrons is probably due to hematin. Zones of decreased reflection, as shown in the curves, are more pronounced in the reflection curve obtained from the surface of the chest than from the cheek, inasmuch as the amount of pigment interposed is correspondingly less. The influence of pigment on these absorption bands is to minimize them. This will be brought out more fully later in the paper.

TABLE 1

Analysis of color values obtained from spectrophotometric curves of figure 1

Curve	Area	Total color excitation	Red	Green	Violet	Dominant wave-length	Purity	Relative luminosity
		units	*per cent*	*per cent*	*per cent*	*milli-microns*	*per cent*	*per cent*
1	Chest	6,708	41.5	32.7	25.8	598	26	36.7
2	Cheek	3,703	44.1	31.7	24.2	600	33	20.5

Table 1 represents a summary of data obtained by an analysis of the spectrophotometric curves in figure 1, following the methods outlined by the Committee on Colorimetry of the Optical Society of

America (10); these methods consist of the translation of reflection values into terms of color, namely hue or dominant wavelength, purity, and brilliance or relative luminosity. In general, the quantity and quality of color are expressed in terms of stimulus or color excitation units, which include the summated values of the red, green and violet. These values determine the index of saturation or purity of hue as well as the dominant wavelength. The exact procedure used in the analyses is discussed elsewhere (1, 7).

Pigmented skin reflects less light than nonpigmented skin, and stimulates fewer color excitation units, giving a diminished percentage of total brilliance. The skin of the cheek, in this instance, has a relative luminosity value of only 20.5 per cent, as compared to 36.7 per cent for the skin of the chest. The relative percentages of red, green and violet are an index to the hue and the degree of hue, saturation or purity. In this instance there appear to be higher percentages of red and lower percentages of green and violet color excitation values obtained from the cheek than from the chest and correspondingly different percentages of purity. Nevertheless, the red, green and violet values in each instance maintain a linear relationship in spite of the difference in color excitation units produced by the two areas under consideration. This holds true regardless of changes in the quantity of pigment present.

VARIATIONS AMONG DIFFERENT SUBJECTS CLASSIFIED ACCORDING TO TYPE AS BLOND OR BRUNET

A series of blonds and brunets, selected at random, was investigated with reference to variations of pigment content of the skin of widely separated areas of the body. Spectrophotometric reflection curves were obtained from the cheek, chest, inner side of the arm and the dorsum of the middle finger, the hand in the last instance being held about 18 cm. above heart level to reduce the quantity of the superficial venous blood. These curves were analyzed in each instance into the attributes of color, and the resultant data are given in table 2.

Quantitative estimates of the intensity of pigmentation can be made readily from these data. The individual values for the amounts of red, green and violet are maintained at a fairly constant level. This results in little, if any, change in the hue or dominant wavelength, which remains approximately at 590 millimicrons. This corresponds to pure spectral yellow. Likewise the purity or saturation is a func-

TABLE 2

Analyses from spectrophotometric curves of normal blonds and brunets to demonstrate variation of pigment over body areas more or less exposed to light

Case	Type	Age	Sex	Area	Total excitation	Red	Green	Violet	Hue	Purity	Relative luminosity
					units	*per cent*	*per cent*	*per cent*	*milli-microns*	*per cent*	*per cent*
1	Blond	28	F.	Chest	7,295	41.0	33.0	26.0	595	27	39.0
				Hand above heart level	6,812	40.1	32.3	27.6	600	21	36.3
2	Blond	22	F.	Chest	8,202	39.2	34.3	26.5	587	26	44.3
				Hand above heart level	6,775	39.3	34.4	26.3	587	26	36.9
3	Blond	18	F.	Chest	8,422	39.5	34.2	26.3	590	27	46.1
				Hand above heart level	7,848	40.0	33.8	26.2	590	27	42.7
4	Blond	32	M.	Chest	8,579	39.0	34.1	26.9	590	24	44.2
				Cheek	5,973	40.3	32.8	26.9	598	23	33.0
5	Brunet	35	M.	Inner side of arm	6,924	43.9	34.6	21.5	590	43	41.7
				Cheek	4,372	41.2	34.0	24.8	590	31	24.3
6	Brunet	36	M.	Inner side of arm	6,601	41.3	35.2	23.5	587	37	37.3
				Cheek	3,710	43.9	33.3	22.8	597	37	20.9
7	Brunet*	32	F.	Chest	5,024	42.0	32.6	25.2	596	30	28.1
				Hand above heart level	5,706	41.3	34.0	24.7	592	28	32.4
				Cheek	4,904	41.2	32.8	26.0	596	27	26.8

* Much generalized tanning.

tion of the amount of red, green and violet color excited. The blond types manifested a more constant percentage of purity, ranging from 21 to 37 per cent, than did the brunet types, whose percentage varied from 27 to 37 per cent, with one value as high as 43 per cent. In general, as the percentage of red summation increased, the percentage of violet decreased, with very little variation in the percentage of green color. That is to say, the linear relationships were preserved in these types of light and dark complexions.

The brilliance, however, underwent marked variation, and apparently in direct proportion to the absence of pigment present in the specimen of skin under observation. The amount of pigment determines the total amount of the summated excitation values for red, green and violet. For instance, in the case of a brunet, skin from an area such as the chest or the inner side of the arm (which had received very little exposure to sunlight) would reflect in some cases more light than skin (blond) which had become heavily pigmented through constant exposure. Although pigment affects the brilliance of color, in and of itself, it does not alter the values of the dominant wavelength and purity. Blonds and brunets are undistinguishable except for relative variation in brilliance or luminosity.

TABLE 3

Analyses from spectrophotometric curves of a Negro, Chinese and Japanese

Type	Age	Sex	Area	Total excitation	Red	Green	Violet	Hue	Purity	Relative luminosity
				units	*per cent*	*per cent*	*per cent*	*milli-microns*	*per cent*	*per cent*
Negro	42	M.	Chest	3,316	42.4	33.8	23.8	590	35	18.6
			Hand above heart level	1,272	44.3	36.3	19.4	585	50	7.5
Chinese	40	M.	Chest	6,329	39.8	35.9	24.5	585	33	33.7
			Malar region	5,753	42.9	34.0	23.1	590	33	32.0
			Hand above heart level	4,883	39.0	34.7	26.3	585	28	27.2
Japanese	30	M.	Inner side of arm	5,240	39.5	33.0	27.5	595	22	28.0
			Hand above heart level	4,409	40.4	34.8	24.8	587	31	24.3

Variations in subjects of different races

The color of the skin has always held an important place among typical criteria of race. Records have been obtained on a number of subjects (fig. 2), of which the values for a full-blooded negro, a Chinese and a Japanese are tabulated for purposes of comparison (table 3).

The skin of the negro reflects considerably less light than the skin of the Japanese or the Chinese. A percentage of relative luminosity

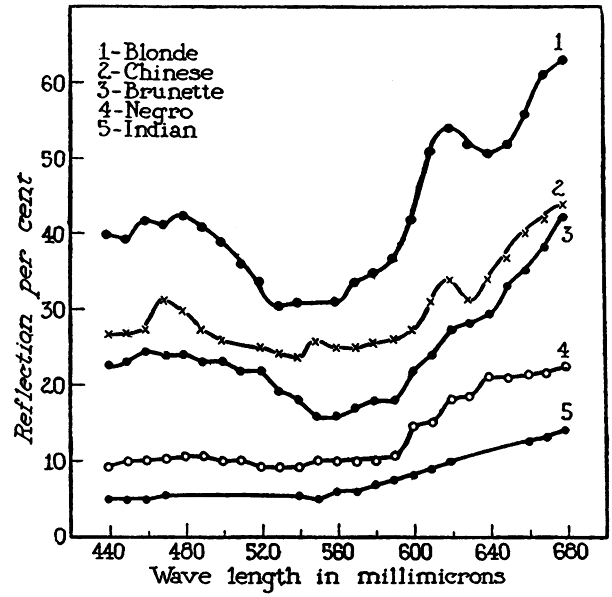

FIG. 2. A SERIES OF SPECTROPHOTOMETRIC CURVES BY THE REFLECTION METHOD OBTAINED FROM THE SKIN OF SUBJECTS OF VARIOUS RACES

or brilliance of 7.5 was obtained in the area of skin from the dorsum of the hand of the negro. The surface of the chest, however, which was ordinarily covered, reflected 18.6 per cent of the light falling on it. Moreover, the percentage values for red, green and violet appear to be in a different relation to each other. Nevertheless they have maintained the same linear relationship, as demonstrated in the skin of the white subject. The purity of the color in the area of the hand reaches

50 per cent, but the hue or dominant wavelength remains constantly near the region of 590 millimicrons.

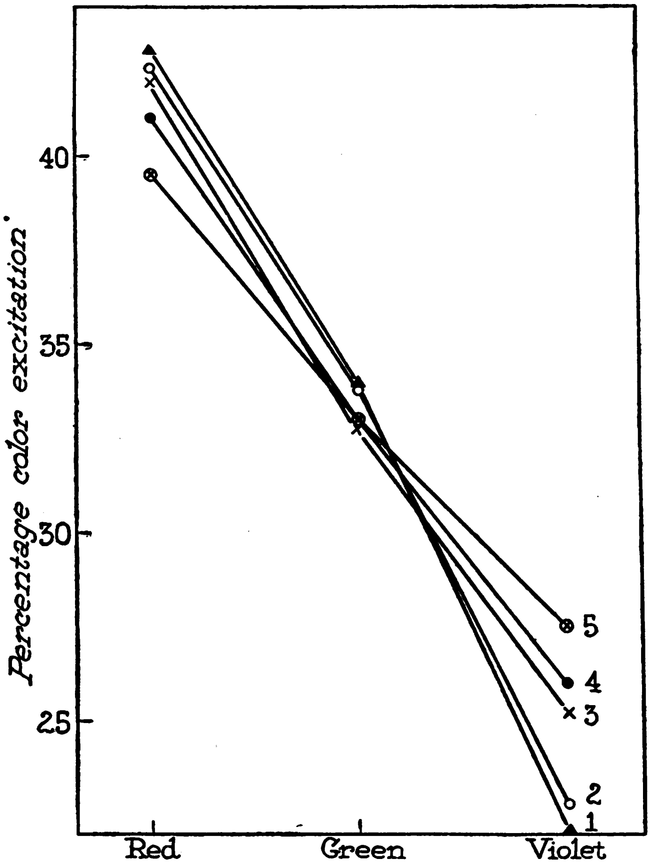

FIG. 3. PERCENTAGE COLOR EXCITATION VALUES OBTAINED FROM SPECTROPHOTOMETRIC DATA IN PERSONS EXHIBITING VARYING DEGREES OF PIGMENTATION: *1*, CHINESE; *2*, NEGRO; *3*, BLOND; *4*, BRUNET AND 5, JAPANESE

Data obtained by the reflection method, after being analyzed into fundamental red, green and violet components for the blond, brunet, negro, Chinese, and Japanese have been plotted and are shown graphically in figure 3. On the basis of specification of color alone, a definite distinction cannot be made as to whether a subject is a member of one race or another.

Todd and Van Gorder (9), in anthropologic studies on the skin of the American negro, utilized the system of spinning tops (Bradley) to estimate the composite coloring of the skin with particular regard to the content of the black pigment. This work was part of a larger research on the correlation of various physical features and was presented as an effort to promote greater accuracy in the quantitative estimation of the color of the skin. The method does not provide for the analysis of color as defined according to its attributes of hue, purity and relative luminosity, but tabulates the records obtained in the registration of brightness, or lack of it, in the skin of the negro. Our work confirms the impression of these authors that the color of the skin is a faulty racial test when used without regard to other physical features of the body.

We have had the opportunity of making spectrophotometric examinations of the color of the skin of a group of native American Indians of three distinct tribes. As far as could be determined by physical inspection, or ascertained by direct questioning, these Indians were free from an admixture of white or negro blood. Table 4 presents an analysis of data obtained from reflection curves of the skin of various parts of the body in subjects of both sexes and of different ages.

The American Indian has long been known as a member of the "red" race. This name seems to have been given the race because of the custom of smearing their faces with ochre and not because of any redness in the skin itself. Clinical inspection of the skin of the American Indian suggests a color resembling bronze. As far as is known to us, an attempt has not been made previously to analyze the color of the Indian skin according to accurate standards of color.

The uniformity of results obtained in the data representing fundamental color values, as shown in table 4, is of particular interest. The various areas of skin observed show a degree of brilliance or relative luminosity inversely proportionate to the density of the screen of pigment present. This relationship was demonstrated similarly in an analysis of the other racial types, namely, the white, black and yellow. The hands and face are, of course, much darker than such

TABLE 4

Analyses from spectrophotometric data in American Indians

Tribe	Age	Sex	Area	Total excitation	Red	Green	Violet	Hue	Purity	Relative luminosity
				units	*per cent*	*per cent*	*per cent*	*milli-microns*	*per cent*	*per cent*
Winnebago	23	M.	Chest	4,678	44.6	33.3	22.1	590–595	41.0	26.8
			Malar region	3,508	41.8	35.9	24.3	590–595	34.0	19.6
			Hand above heart level	2,421	42.1	33.7	24.2	590–595	34.0	13.5
	21	M.	Chest	5,210	42.7	35.2	22.1	585	41.0	29.9
			Malar region	3,993	38.9	31.1	30.0	620	11.0	20.8
			Hand above heart level	2,050	40.4	33.7	25.9	595	31.0	11.1
Kiowa	40	Step-father	Shoulder (protected)	5,394	41.2	34.2	26.6	590	33.0	29.9
			Malar region	3,268	44.1	31.1	24.8	605	30.0	17.7
			Hand at heart level	1,067	46.5	35.7	17.8	587	55.0	6.5
	45	Mother	Breast	4,622	42.8	33.1	24.1	596	32.0	25.8
			Malar region	3,770	43.5	32.3	24.2	600	33.0	20.9
			Hand at heart level	1,905	40.5	34.2	25.3	590	30.0	10.4
	18	Son	Malar region	4,035	41.2	33.8	25.0	590	30.0	22.2
			Hand at heart level	1,851	44.6	33.8	21.6	590	43.0	10.4
	24	Daughter	Shoulder (protected)	3,015	44.8	32.9	22.3	595	39.0	16.7
			Malar region	4,217	41.5	32.9	25.6	595	28.0	23.1
			Hand at heart level	2,377	35.8	33.5	30.7	595	9.0	11.6
Osage	32	Father	Malar region	3,904	38.5	32.4	29.1	605	15.0	20.4
			Hand above heart level	2,480	37.3	33.3	29.4	600	14.0	13.0
	27	Mother	Malar region	3,843	39.8	31.1	29.1	620	15.0	19.9
			Hand above heart level	3,201	40.2	31.3	28.5	619	17.0	17.6

TABLE 4—*Concluded*

Tribe	Age	Sex	Area	Total excitation	Red	Green	Violet	Hue	Purity	Relative luminosity
				units	*per cent*	*per cent*	*per cent*	*milli-microns*	*per cent*	*per cent*
Osage	10	Son	Malar region	5,838	37.0	32.7	30.3	605	11.0	29.3
			Hand at heart level	3,045	39.2	33.9	26.9	590	24.0	16.4
	7	Son	Malar region	6,117	38.0	33.5	28.5	595	18.0	32.5
			Hand at heart level	2,737	39.4	34.0	26.6	590	26.0	14.9

protected areas as the trunk. This would be expected from the difference in habitual exposure to sunlight.

The hue or dominant wavelength throughout the entire series of Indians averaged 593 millimicrons, if the malar areas are excluded. The malar areas in most of the cases examined appeared to contain a little more red, in one case attaining 620 millimicrons. The average was 603 millimicrons. This departure may be because of some anatomic peculiarity of the skin in the malar area, especially as regards its texture, which may allow an undue influence to be exerted on the color of the skin by the superficial capillaries and telangiectasia so commonly found in this region.

The subjects from the Winnebago and Kiowa tribes revealed a level of hue which was similar to that recorded previously for other subjects regardless of race. The values of purity are relatively high except in two instances, namely, in the malar area of the second Winnebago Indian (11 per cent) and in the hand of the fourth Kiowa Indian (9 per cent). In these cases it is possible that the presence of superficial blood may have affected the readings obtained. The relative luminosity or brilliance is uniformly low, as would be expected, since the skin of the Indian, like that of the negro, presents a dark surface and hence reflects little light. In no case did the brilliance exceed 30 per cent in the lightest areas, and in one case (in the hand of the first Kiowa Indian) it dropped to 6.5 per cent, the lowest level of any of our records.

The Osage Indians were a family group and presented a few variations distinguishing them from the other types of Indians, although perhaps not characteristically so. The dominant wavelength lies in the orange region of the spectrum, in one instance at 620 millimicrons. The relative proportions of red, green and violet show a change in the linear relationship by a lowering of the value for red and some-

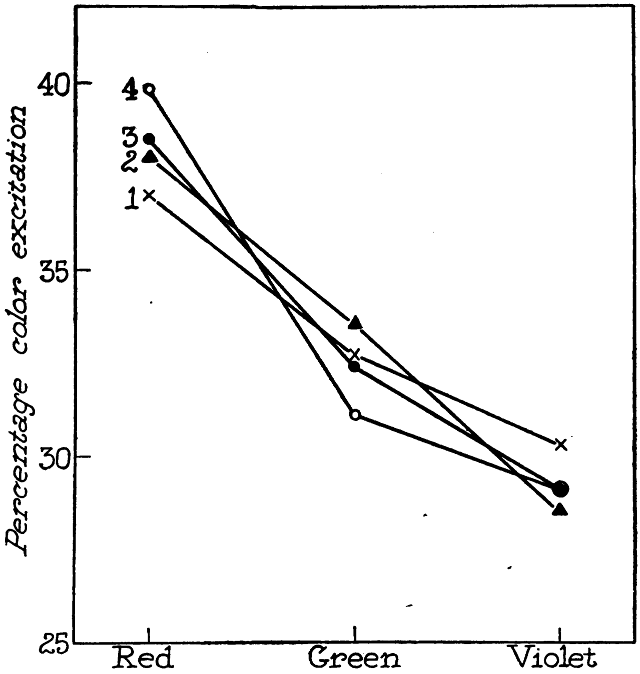

FIG. 4. PERCENTAGE COLOR EXCITATION VALUES FROM SPECTROPHOTOMETRIC DATA IN THE OSAGE INDIAN FAMILY GROUP: *1*, SON; *2*, SON; *3*, FATHER, AND *4*, MOTHER

times an exaggerated increase in the value for violet. A break in the linear arrangement of these percentage values is reflected, in turn, in the values of the dominant wavelength and purity.

Figure 4 is a graphic representation of the percentage values resulting from an analysis of the reflection curves obtained in the four members of the Osage Indian family. Curves 1, 3 and 4 show a slight tendency to deviation from a straight line as drawn through the specified value of the green component. This is especially so in curve 4, which is the record of color values from the malar area of the

TABLE 5

Analyses of spectrophotometric data in subjects presenting pigmentary disturbances

Type	Age	Sex	Area	Total excitation	Red	Green	Violet	Hue	Purity	Relative luminosity
				units	*per cent*	*per cent*	*per cent*	*milli-microns*	*per cent*	*per cent*
Argyria (confirmed clinically and microscopically)	40	M.	Breast	8,094	37.2	34.2	28.6	586	18	43.0
			Malar region	4,398	38.0	34.2	27.8	587	21	23.5
			Hand at heart level	3,064	35.8	33.6	30.6	590	10	15.5
Addison's disease	36	F.	Chest	5,735	36.7	33.4	29.9	590	12	30.0
			Malar region	3,467	41.9	34.0	24.1	590	34	20.0
			Hand at heart level	2,425	40.9	32.4	26.7	590	25	13.0
Arsenism	40	M.	Back (pigmented)	5,354	41.6	34.9	23.5	587	36	30.3
			Malar region	4,274	42.4	33.2	24.4	595	32	22.6
			Hand at heart level	2,787	43.7	34.5	21.8	590	41	16.6
Arsenism	42	M.	Back (pigmented)	5,863	42.9	36.0	21.0	585	45	34.6
			Forehead	5,084	43.3	34.0	22.7	590	40	28.8
			Hand above heart level	3,707	45.7	34.3	20.0	590	45	21.7
Jaundice	43	M.	Malar region	5,156	41.8	33.3	24.9	595	30	28.4
			Hand above heart level	5,371	37.3	35.4	27.3	580	24	28.3

mother of the family. Curve 2 is a straight line, being similar in this respect to all the previous readings obtained on subjects regardless of race or degree of pigmentation. Subsequent readings in other conditions have indicated that the variations presented by the curves 1, 3 and 4 are indicative of the influence exerted by the superficial blood on the color of the skin. This will be dealt with in greater detail in study III of this series. We may assume that the skin of this group of Osage Indians, being of unusually fine grained and thin texture, allowed greater penetration of the surface blood as a factor in influencing its color.

VARIATIONS IN SUBJECTS MANIFESTING ABNORMAL TYPES AND DEGREES OF PIGMENTATION

Further data were obtained on types of pigmentary disturbances in order to permit of a comparison of these data (table 4) with similar analyses of subjects showing normal variation in pigmentation according to exposure to sunlight or to racial type alone. The results are given in table 5.

The argyria was evident on clinical inspection and was of many years' standing. Silver nitrate had been administered for the treatment of ulcer over a period of several years. The diagnosis of argyria was confirmed by histochemical studies on a section of skin removed from the neck. Analysis of the curves obtained does not indicate any marked variations from the gradations of normal pigmentation previously investigated. The dominant wavelength remains at 586 to 590 millimicrons; the percentage of relative luminosity varied according to the amount of habitual exposure of the part, although a value of 43 per cent in the region of the breast indicates lack of pigment, either of melanin or silver. The purity or saturation tends to be fairly low and this may be related to the metallic luster characteristic of argyria.

The values for Addisonian and arsenical pigmentation are not different from those obtained in subjects exhibiting normal variations in pigment. The amount of brilliance recorded by the two cases of arsenism is of interest. The areas of skin on the back were particularly pigmented and were found to be the darkest areas on the body. However, in each case, values were obtained showing a reflection of more than 30 per cent of the total light falling on the surface. This bears out the statement made previously that the eye is a faulty instrument for analyzing the quantity and quality of color.

Records were obtained from two subjects with jaundice and the curves analyzed as in the previous instance. The intensity of the jaundice was quite pronounced; in each case quantitative estimation of the serum bilirubin by the van den Bergh technic showed 15 to 20 mgm. for each 100 cc. of blood. The spectrophotometric data in these instances, when analyzed into the fundamental attributes of color, show that jaundice of itself does not alter the normal relations of the color of the skin. The percentages of red, green and violet color and the hue, purity and relative luminosity are practically identical in the subjects with jaundice and in the Japanese and Chinese (table 3). It is reasonable to suppose, however, that degrees of jaundice will reflect themselves in the purity or saturation value of the hue predominating in the skin. However, it is quite evident that the fundamental hue of the skin is not altered by subsequent deposits of bilirubin such as occur in jaundice, without regard to the intensity of the process.

Staining of the tissues of the body by other pigments is occasionally seen after excessive ingestion of such substances as carrots, spinach and egg-yolk, which contain a relatively high percentage of lipochromes such as xanthophyll and carotin. These pigments play an important part in the coloration of leaves and flowers and undoubtedly also contribute the yellow color to animal fat such as that which is present in the subcutaneous tissue. Preliminary investigations on subjects giving evidence of coloration of the skin from such products indicate that the spectrophotometric data obtained will be exactly similar to the records of the subjects with jaundice.

Pigment is one of the few substances which is enjoyed in common by plants and animals. In plants there is a zonal distribution of color depending on the amount of exposure to the direct rays of the sun. In seaweeds, for instance, there is gradation from a green color on the surface, through olive, orange and red as the dimly lighted ocean bottom is approached. This affords an admirable adaptation to environment. It may be true in animals, as in plants, that the pigment on the surface of the body acts in some degree as a regulator of metabolism. The fundamental hue of the human skin remains constant in the spectral region of 590 millimicrons regardless of the amount of habitual exposure of the subject to sunlight. Melanin is laid down as a screen, separating the external environment, on the one hand, from the blood and deeper tissues, on the other. It may act as a filter in regard to irradiation to which the surface of the body is exposed, possibly barring, by reflection, such fractions of energy as are injurious and unsuitable, and admitting by absorption such portions as are desirable, converting them into a form of energy convenient to immediate service or adaptable to storage for the future needs of the organism.

CONCLUSIONS

1. Spectrophotometric analysis of the human skin demonstrates certain fairly constant features regarding its color.
2. The fundamental hue or dominant wavelength of the skin lies in the spectral region 590 millimicrons (sodium yellow).
3. Deposition of melanin in the skin in response to more or less exposure to sunlight does not disturb the hue or purity of its color but decreases the relative luminosity. The more melanin present, the lower the percentage of light reflected from the surface of the skin and the lower the brilliance.
4. Pigment is not a racial characteristic. The same hue prevails in the white as in the so-called black, red and yellow races.
5. Deposits of pigment in disorders of the skin do not alter the fundamental attributes of its color except as they lower the value for brilliance.
6. Jaundice in the skin can be estimated quantitatively but it does not affect the normal values for hue, purity or relative luminosity.

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