KSG; Note + return

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INTER-SOCIETY COLOR COUNCIL

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NEWS LETTER NO. 16

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Note: The News Letter is issued from time to time by the Inter-Society Color Council to all members for the purpose of bringing to their attention the current activities of the Council and to serve in a clearing house capacity in keeping members informed concerning recent publications on color in the arts, sciences, industries and education.

The material for the News Letter is obtained from several sources, particularly from the representatives of member-bodies. It is hoped that each member-body representative will keep the News Letter in mind and furnish material that may be of interest. The basic color problems of all groups are alike and one industry can learn much from the others.

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All members are urged to send items of interest (similar to those in this News Letter) to I. H. Godlove, Editor, c/o E. I. du Pont de Nemours & Company, Inc., P. O. Box 518, Wilmington, Del.

Color Names in the U. S. Pharmocopoeia and National Formulary

(A partial report of the committee on color problems, by Deane B. Judd, Chairman).

I. INTRODUCTION

In 1931 at the first annual meeting of the Council, Chairman Gathercoal presented the problem of standardization of color names in the United States Pharmacopoeia briefly as follows:

"A means of designating colors in the United States Pharmacopoeia, in the National Formulary, and in general pharmaceutical literature is desired; such designation to be sufficiently standardized as to be acceptable to science, sufficiently broad to be appreciated and usable by science, art, and industry, and sufficiently commonplace to be understood at least in a general way, by the whole public."

This problem was referred to the Committee on Color Measurement and Specification, Dr. I. H. Godlove, Chairman. After a protracted investigation into the respective merits of the principal color systems, a committee report was published containing general recommendations for the designation of color by name in the U. S. Pharmacopoeia and the National Formulary.

There being no adverse criticism of the general plan (though numerous constructive suggestions were received for improvement in its details), this plan was considered acceptable to our Council; and Dr. Gathercoal arranged to have Mr. Kenneth L. Kelly placed as a research associate of the American Pharmaceutical association at the National Bureau of Standards to carry on the research and colorimetry. This work has been in progress under the direction of the chairman since May, 1936. It has been found expedient to try out some elaborations and revisions of the Inter-Society Color Council general plan.

Since the system so developed promises to be useful in connections other than pharmaceuticals, it has been thought worth while to present the elaborations and revisions to the delegates of the Inter-Society Color Council through the medium of the News Letter. This is a first step toward possible adoption of this or some allied plan as the official color-name system of the Inter-Society Color Council.

II. THE INTER-SOCIETY COLOR COUNCIL GENERAL PLAN

The tri-dimensional arrangement of color used by many psychologists was selected as the most promising basis for a solution to the problem. In this arrangement the colors of all surfaces are represented by points in a tridimensional figure, each point representing a color. Light colors are placed near the top of the figure and dark colors near the bottom, white being the topmost color and black the bottommost. Along the vertical line connecting black and white are represented grays from dark through medium to light gray; this line is called the gray axis. Hue is represented by angle about the gray axis, and saturation or strength of color is represented by distance from the gray axis. It was proposed to divide this surface-color solid into compartments each containing roughly the same number of just distinguishable colors and to assign a color name to each compartment or pocket of the color solid. As a guide to the setting up of boundaries of this sort, the Munsell color system was chosen. (1)

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(1)

Report of the Committee on Measurement and Specification, by I. H. Godlove, Chairman, Bulletin No. 1, Inter-Society Color Council, June 7, 1932.

The color names were to be formed of three to six-word phrases constituting the generalized statement of the attributes of the color within the pocket. In doing this the suffix, ish, and the following 12 words only were to be used, namely: red, yellow, green, blue, purple, light, medium, dark, strong, moderate, weak, and the adverb, very. These words were to be defined by means of the Munsell charts under the condition stated below. Light, medium, and dark, were to correspond, respectively, to high, medium, and low lightness (Munsell term: value); strong, moderate, and weak, to high, medium, and low saturation (Munsell term: chroma). The adverb, very, was to be used to describe very high or very low lightnesses or saturation so that five positions on the lightness scale and five on the saturation scale could be described.

For the hue designations of weak and very weak colors, the terms, red, yellow-red, yellow, green-yellow, green, and so forth, were to be used, corresponding to the Munsell hue scale positions. For the moderate colors, these hue names were to be used, and in addition ten more compounded from these, and denoting hues visually half-way between: for example, red-yellow-red, yellow-red-yellow, and so forth. For the strong and very strong colors, the foregoing twenty hue names were to be used, and in addition twenty more were to be formed from them by the use of the ending, ish; but these will not be detailed because they have now been given up as too cumbersome.

Wherever there exists a color name so well established and common that its use aids in the visualization of the colors of a pocket, these names were to be listed in a table in parallel with the corresponding designation of the colors of the group. In using such names, the standardizations presented in the Maerz and Paul Dictionary of Color were usually to be followed.

For purposes of greater precision, the centers and the boundaries of the pockets of the color solid were to be specified in tristimulus terms insofar as possible. The value of the trilinear coordinates x and y were to be given, and for this purpose, where computations from spectral data were made, the standard observer and system of colorimetric specification recommended in 1931 by the International Commission on Illumination (ICI) were to be used.

The standard light source wherever possible should be one of the three ICI standards. In the case of reflecting materials, except in special specified circumstances, the illumination should be incident at an angle of 45° and the angle of observation should be normal to the surface of the specimen; and in the case of transmitting materials, the angles of incidence and observation should both be normal to the two parallel plane surfaces of the specimen or of the retaining walls of the vessel containing it.

III. PRESENT REVISION AND ELABORATION

The many suggestions for the improvement of the details of this general plan have mainly taken the form of various schemes to shorten the number of words in a color name and to make more use of common color names. Some of these revisions were made specific in a series of conferences in 1933 and 1934 between Dr. Godlove, and the present chairman, the aptness of the names obtained being largely judged by comparison with the Maerz and Paul Dictionary of Color. Others have resulted from suggestions by Dr. E. N. Gathercoal, Chairman, Committee on the National Formulary, by Dr. K. S. Gibson, chief of the colorimetry section, National Bureau of Standards, by Mr. M. Rea Paul, Chairman, Inter-Society Color Council, and by Mr. Kenneth L. Kelly, National Formulary research associate at the National Bureau of Standards. As already mentioned, many awkward and long hue names were avoided by giving up the proposed 40-point division of the hue circuit for strong colors; the present plan includes a 5, a 10, and a 20-point division, but no 40. Revisions which have to do with obtaining simpler color names may conveniently be discussed under two headings: (1) new hue names, and (2) abbreviated modifiers.

1. The new hue names.

The three-component hue names originally recommended from the Munsell system, such as red-purple-red, and green-yellow-green, have been given up and in their place two-component terms such as purplish-red and yellowish green have been adopted.

Four new hue names have been fitted logically into the system. They are first, orange, as a substitute for light and medium yellow-red, second, pink, as a substitute for light purplish red, third, brown, as a substitute for dark yellow-red, and fourth, olive, as a substitute for dark greenish yellow. These hue names have given rise to the following series of compound names: Orange-red, (orange), yellow-orange; purple-pink, (pink), red-pink, orange-pink; brown-red, (brown), yellow-brown; olive-brown, (olive), green-olive. Table 1 gives all the hue names of the present system, together with the letters which are used for abbreviations of them.

2. The abbreviated modifiers.

The first plan included such long modifiers of the hue name, as, very dark, very weak. An attempt has been made to shorten these modifiers by finding suitable one-word equivalents for the phrases: light, weak; light, strong; dark, weak; dark, strong; and similar combinations including the adverb, very. Table 2 shows these abbreviated modifiers and it also shows in parentheses the corresponding unabbreviated phrases originally proposed. Note that the phrases in parentheses are not expected to be generally used. Thus, the modifiers, medium, moderate, will only be used to indicate a range of color as in saying yellow, weak to moderate, or in saying yellow, light to medium. But it is expected not to use the term, medium, moderate yellow; instead one will write merely yellow.

3. Deviations from the Munsell standards.

The Munsell designations of the boundaries of the approximately 500 compartments, each one designated by a color name, have all been tentatively set and tested not only against the colors of the Maerz and Paul Dictionary but also against many of the color names already used in the National Formulary. It is expected that the final adjustment of boundaries will not be made until the colorimetry of drugs and chemicals is well along toward completion. Hence, although further large changes are not expected, no detailed discussion of these boundaries will be given at this time.

However, in selecting boundaries for the various hues it was found necessary in about one-third of the cases to take account of what appears to be a technical defect of the Munsell Book of Color, namely: the samples which are labeled with the same hue notation do not really have colors of constant hue. For example, the Munsell sample labeled YR 7/10 seems to be a good orange, neither inclining toward the red nor toward the yellow, but the sample labeled YR 7/4 seems to incline definitely toward red and the sample labeled YR 7/2 inclines still more toward red. This has been taken into account by making the strong color represent our typical orange hue, but the weakest color is taken near the red boundary for very weak orange. This type of hue shift extends from red to yellow.

A somewhat similar defect was found in the blue. The Munsell samples labeled chroma 2 seemed to us to be good blues inclining neither toward the green nor toward purple, but the samples labeled chroma 8 and higher seemed to us to incline definitely toward green. This was taken into account by making the Munsell samples of chroma 8 and hue BPB represent our typical blue; we have not included in the present system any hue name for this Munsell name such as blue-purple-blue or purplish blue, but pass instead directly from blue to purple-blue (see table 1). In this way it happens that our hue names for moderate and strong colors, based in the main on the Munsell 20-point hue division, number only 19.

It should be remarked that from simple inspection of the Munsell charts it is hard to form a judgment of the constancy or inconstancy of the hue of the sample bearing the same Munsell hue designation. For example, by adapting the eye to purple or red purple, the Munsell charts from red to yellow may be made to appear to deviate in the direction opposite to that which we believe is to their true direction of error. However, attempts to assign suitable color names from the Munsell system to samples viewed separately have consistently failed until account was taken of this hue shift. The direction of this hue shift has also been checked by extensive data on the spacing of the colors in the Munsell Book of Color gathered in an informal cooperative effort by the Bureau of Agricultural Economics, the National Bureau of Standards, the Munsell Color Company, and various users of the system.

IV. STANDARDS.

It has been expected that the use of this system of color names would be carried on according to three different methods involving radically different degrees of accuracy. The first and probably most to be used method involves no standards whatever, but depends solely upon the descriptive value of the color names. On this account it has been our earnest aim to construct a system of easily understood color names and to adjust the arbitrary boundaries serving to define these names so as to do the least possible violence to present usage. It may be expected that after a few years of use, the color names will increase in descriptive value because the users will gradually become more familiar with their meaning, but every effort has been bent toward making use of present meanings with a view to the reduction of the number of new terms which will have to be learned. The original Inter-Society Color Council basis has lent itself well to this purpose.

A second, and probably much to be used, method of applying these names is by comparison with working standards. The most readily available complete set of working standards is, of course, to be found in the Munsell Book of Color because for the present the tentative definitions of the color names are given only in Munsell terms; but when the definitions are ready to be made final, it is expected that other working standards, for example, those in the Maerz and Paul Dictionary of Color, will be adapted to this purpose. In this case all that is required is the Inter-Society Color Council name for each of the samples given.

The fundamental method of applying this system of color names will be relatively little used. It consists of measuring the spectral reflectance of the sample, computing the tristimulus specification of it according to the 1931 ICI standard observer and coordinate system, and deriving the color name from these fundamental data. This requires that the boundaries defining the colors all be stated in tristimulus terms, and it is anticipated that this will eventually be done. All of the colorimetry of drugs and chemicals so far carried out on this project at the National Bureau of Standards, is convertible to fundamental terms, and the present tentative boundaries expressed in terms of the set of master standards left in custody of the National Bureau of Standards by the Munsell Color Company may be transformed to tristimulus terms by the aid of determination of the spectral reflectances of these master Munsell standards. The fundamental method may then be applied, but it is expected that it will be necessary only for materials of especial technical or legal significance, and only in referee cases by a standardizing laboratory.

V. EXAMPLES OF SUGGESTED REVISION OF THE NATIONAL FORMULARY.

The following suggested revisions of the National Formulary will indicate how the new system of color names works out. The suggested name is underscored, the old name is given in parentheses.

AVENA

Unground Oat: <u>Light yellow-brown to dusky yellow</u> (pale yellow or pale yellowish green); up to 1.5 cm. in length . . . .
Powdered Oat: <u>Very weak yellow</u> (whitish); fragments of epicarp with thin-walled . . . .

CALENDULA

Unground Calendula: Florets from 15 to 25 mm. long, <u>dusky yellow to strong brown</u> (yellow or orange) 1- to 3-toothed, 4- to 5-veined, margin nearly entire . . . .

Powdered Calendula: <u>Dusky yellow to yellow-brown</u> (light yellow to orange-yellow); a few characteristic, non-glandular hairs, consisting of . . . . .

PERSIO

Cudbear is a very dusky red-purple (purplish red) powder prepared from species of Roccella De Candolle, Lecanora Acharius, or other lichens . . . . . .

CALAMINA PRAEPARATA

Prepared Calamine is a pale pink (pink) powder which will pass through a No. 100 sieve. It is odorless and almost tasteless. . . . . . .

CARMINUM

Carmine occurs in irregular, angular, deep red (bright red) fragments, or as a powder, without odor or taste. When burned, it emits an odor resembling that of burned feathers . . . . .

HYDRARGYRI IODIDUM RUBRUM

Red Mercuric Iodide is a vivid red (scarlet-red) amorphous powder without odor. It is stable in the air and nearly tasteless. Red Mercuric Iodide is practically . . . .

VI. COUNCIL ACTION DESIRED.

In summary it should be noted that (1) the general plan suggested in 1931 by the Inter-Society Color Council has been followed, (2) certain elaborations and revisions have been proposed, but (3) no final selection of arbitrary boundaries defining the colors to be known by definite names has been made.

This report is to be presented for formal approval at the February meeting of the Council. Criticism of this report prior to the meeting, particularly by delegates, is solicited, and should be sent to D. B. Judd, chairman, Inter-Society Color Council Committee on Color Problems, National Bureau of Standards, Washington, D. C.

Table 1, - The Hue Names

Strong and Moderate Colors (20-point hue division)		Weak Colors (10-point hue division)		Very Weak Colors (5-point hue division)		Grays and Near Grays (No hue division	
For very light colors:							
		Purple-pink	(PPk)	Purplish white	(pWh)		
		Pink	(Pk)				
		~~Red-pink~~	~~(RPk)~~	Pinkish white	(pkWh)		
		Orange-pink	(OPk)				
		Orange	(O)				
		Yellow	(Y)	Yellowish white	(yWh)	White	(Wh)
[Yellow-green]		Green-yellow	(GY)				
		Green	(G)	Greenish white	(gWh)		
		Blue-green	(BG)				
		Blue	(B)	Bluish white	(bWh)		
		Purple-blue	(PB)				
		Purple	(P)				

For light and medium colors:

Strong and Moderate Colors (20-point hue division)		Weak Colors (10-point hue division)		Very Weak Colors (5-point hue division)		Grays and Near Grays (No hue division	
Red purple	(RP)	Red-Purple	(RP)				
Purplish red	(pR)						
Red	(R)	Red	(R)	Reddish gray	(G) [rGr]		
Orange-red	(OR)						
Orange	(O)	Orange	(O)				
Yellow-orange	(YO)						
Yellow	(Y)	Yellow	(Y)	Yellowish gray	(yGr)		
Greenish yellow	(gY)						
[Yellow -] Green-~~yellow~~ ?	(GY)	Green-yellow	(GY) [YG]				
Yellowish green	(yG)						
Green	(G)	Green	(G)	Greenish gray	(gGr)	Gray	(Gr)
Bluish green	(bG)						
Blue-green	(BG)	Blue-green	(BG)				
Greenish blue	(gB)						
Blue	(B)	Blue	(B)	Bluish Gray	(bGr)		
Purple-blue	(PB)	Purple-blue	(PB)				
Bluish purple	(bP)						
Purple	(P)	Purple	(P)	Purplish gray	(pGr)		
Reddish purple	(rP)						

Table 1, (Continued) - The Hue Names

For dark colors:

Strong and Moderate Colors (20-point hue division)		Weak Colors (10-point hue division)		Very Weak Colors (5-point hue division)		Grays and Near Grays (No hue Division)
Red-purple	(RP)	Red-purple	(RP)			
Purplish red	(pR)					
Red	(R)	Red	(R)	Dark reddish gray	(dark rGR)	
Brown-red	(BrR)					
Brown	(Br)	Brown	(Br)	Brownish gray	(brGr)	
Yellow-brown	(YBr)					
Olive-brown	(OlBr)	Olive-brown	(OlBr)			
Olive	(Ol)			Olive-gray	(OlGr)	
Green-Olive	(GOl)	Green-Olive	(GOl)			
Yellowish green	(yG)					
Green	(G)	Green	(G)	Dark greenish gray	(dark gGr)	
Bluish green	(bG)					Dark gray (dark Gr)
Blue-green	(BG)	Blue-green	(BG)			
Greenish blue	(gB)					
Blue	(B)	Blue	(B)	Dark bluish gray	(dark bGr)	
Purple-blue	(PB)	Purple-blue	(PB)			
Bluish purple	(bP)					
Purple	(P)	Purple	(P)	Dark purplish gray	(dark pGr)	
Reddish purple	(rP)					

For very dark colors:

		Red-purple	(RP)			
		Red	(R)	Reddish black	(rBk)	
		Brown	(Br)	Brownish black	(brBk)	
		Olive-brown	(OlBr)	Olive-black	(OlBk)	
		Green-Olive	(GOl)			
		Green	(G)	Greenish black	(gBk)	Black (Bk)
		Blue-green	(BG)			
		Blue	(B)	Bluish black	(bBk)	
		Purple-blue	(PB)			
		Purple	(P)	Purplish black	(pBk)	

Table 2. INTER-SOCIETY COLOR COUNCIL SYSTEM OF ADJECTIVES AND THEIR TENTATIVE CONTRACTIONS.

Very Faint (very light, very weak)	Very Pale (very light, weak)	Very Light		
Faint (light, very weak)	Pale (light, weak)	Light	Brilliant (light, strong)	
Very Weak	Weak	(medium moderate)	Strong	Vivid (very strong)
	Dusky (dark, weak)	Dark	Deep (dark, strong)	
	Very Dusky (very dark, weak)	Very dark		

Lightness (Munsell value) ↑

Saturation (strength, Munsell Chroma) →

INVENTORY OF MATERIAL IN THE POSSESSION OF THE MEMBERSHIP COMMITTEE

For the benefit of members of the Council, W. M. Scott, Chairman of the Membership Committee has listed the material available for distribution that is in his possession. Anyone wishing any of the following should address Dr. Scott at 857 Boylston Street, Boston, Mass.

12	Copies	Bulletin No. 1
20	"	News Letter No. 1
10	"	Minutes of Second Annual Meeting (December 28, 1932)
7	"	Address by Chairman Gathercoal at 2nd Annual Meeting
30	"	Report of Committee on Measurement and Specification (December 28, 1932)
5	"	Summary of Resolutions Adopted at the Cambridge Meeting of the I. C. I. Colorimetry Committee (September, 1931)
50	"	Duties of an Official Delegate
150	"	Old Descriptive Leaflets
125	"	New Descriptive Leaflets
40	"	New Bulletin No. 12
70	"	Membership Application Blanks

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MEETING OF WASHINGTON COLORISTS

The Colorists of Washington and Baltimore held the first meeting of their fourth season at the Cosmos Club on Tuesday, November 17, 1936, with dinner at 6:30.

The subject was: "The Industrialist Looks at Color." The present situation might be paraphrased by the Industrialists:

> "I am a busy man. I have color problems. In production work I know what the chemist can do for me. But I have problems of consumer needs and preferences, of tolerances, of production to standard. I want to know in a short interview -- not more than half an hour each -- what the physicist and the psychologist can offer me. What does each know about color?"

Dr. Deane B. Judd of the Colorimetry Section of the National Bureau of Standards spoke for the physicist. Professor Sidney M. Newhall of the Psychology Department of Johns Hopkins University spoke for the psychologist. Dr. A. W. Kenney of the Experimental Station of the DuPont Company, took the part of the industrialist. Having heard what Dr. Judd and Professor Newhall had to say on the subject, Dr. Kenney summed up the situation by indicating that he still had plenty of problems even after hearing about the arsenal of instrument weapons with which the physicist would supply him, and of the response measurements that the psychologist was prepared to make for him.

Mr. Charles Bittinger, chairman of the group, presided. The meeting was well attended, 40 persons being present for dinner, several guests arriving later.

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WORK OF THE PROBLEMS COMMITTEE

The following extract of a letter written recently by Mr. Paul, Chairman of the Council gives the highlights regarding some of the current problems being handled by the Council.

The problems that are being given most earnest consideration at this time, consist of the preparation of a "Who's Who in Color", intended to present the results of a survey that will cover those individuals actively engaged in color activities in this country. The second project is an investigation of color terms that have been adopted by scientific societies, or have become generally accepted, through continued usage, in various industries. With this information in hand, the Council can undoubtedly accomplish much in the way of clearing up confusion that exists in instances where the same term may have two or more meanings, depending largely on the point of view. The third project involves a survey of all color specifications that are accepted as standard methods, such as A. S. T. M. Standard Method of Analysis for the Color Characteristics of Paints in Terms of Fundamental Physical Units (D 307-30). When this survey has been concluded, such information may place the Council in a position to render a truly valuable service to many groups by correcting misapprehension, or advising of what others, in a somewhat related field, are doing. The final project involves a survey of color problems characteristic of the individual fields covered by the different member bodies that compose the Council. We may find that they are similar in many instances, or widely different. It would at least inform us of the character of undertaking that the Council might pursue, that would be of greatest benefit to the technical groups of which our organization is composed.

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STANDARDIZED COLORED MATCHING FLUIDS

The Arny, (Prof. H. V. Arny, Columbia University, College of Pharmacy) "Co-Fe-Cu" standardized fluids are recognized in the recent edition of the United States Pharmacopoeia (U.S.P. XI) in setting the standards of the color of cod liver oil and for the sulfuric acid test for carbonizable substances. The "Co-Fe-Cu" standard fluids are prepared as follows:

Cobaltous Chloride Colorimetric Solution: Dissolve about 60 grams of cobalt chloride, $C_oCl_2.6H_2O$ is enough of a fluid made by mixing 25 cc. of Hydrochloric Acid U.S.P. with 975 cc. of distilled water to make 1000 cc. of test solution. This test solution should be standardized to the 1/4 molar strength (59.496 grams $C_oCl_2.6H_2O$ to the liter) by the following assay: Place 5 cc. in a 250-cc. flask, add 15 cc. of 20 percent sodium hydroxide and 5 cc. of solution of hydrogen dioxide (3 per cent), boil for ten minutes, cool, and add 2 grams potassium iodide, followed by 20 cc. sulfuric acid (1:4). When the precipitate has dissolved, titrate with tenth-normal sodium thiosulphate. Each cubic centimeter of N/10 thiosulphate corresponds to 0.023799 gram $C_oCl_2.6H_2O$.

Ferric Chloride Colorimetric Solution: Dissolve about 50 grams of ferric chloride U.S.P. in enough of a fluid made by mixing 25cc. of hydrochloric acid U.S.P., with 975 cc. of distilled water to make 1000 cc. of test solution. This test solution must be standardized to 1/6 molar strength (45.054 grams $FeCl_2.6H_2O$ to the liter) by the hydrochloric acid, potassium iodide, sodium thiosulphate volumetric assay, found under Liquor Ferri Chloridi (U.S.P. p. 209); 10 cc. of the test solution is employed. Each cubic centimeter of N/10 thiosulphate corresponds to o.027032 gram $FeCl_3.6H_2O$.

Cupric Sulfate Colorimetric Solution: Dissolve about 65 grams of copper sulphate, $CuSO_4.5H_2O$, in enough of a fluid made by mixing 25 cc. of hydrochloric acid U.S.P. and 975 cc. of distilled water, to make 1000 cc. of test solution. This test solution should be standardized to the 1/4 molar strength (62.43 grams ($CuSO_45H_2O$ to the liter) by the acetic acid, potassium iodide, sodium thiosulphate volumetric assay found under Cupri Sulfas (U.S.P. p. 134); 10 cc. of the test solution is employed. Each cubic centimeter of N/10 thiosulphate corresponds to 0.024972 gram $CuSO_4.5H_2O$.

In standardizing the <u>color of cod liver oil</u>, the sample is placed in a tall cylindrical standard oil-sample bottle (120-cc. capacity) and matched against the Co-Fe-Cu standard contained in a similar oil-sample bottle. The standard fluid is made by mixing 11 cc. of the cobaltous colorimetric solution, 76 cc. of the ferric colorimetric solution and 33 cc. of distilled water.

As to matching the colors produced by the sulfuric acid test for <u>carbonizable substances</u> the following wording of the test as applied to citric acid is typical:

> Mix 0.5 grams of powdered Citric Acid with 5 cc. of Sulfuric Acid in a test tube that has been previously rinsed with sulfuric acid and maintain the temperature

> of the mixture at 90°C. for one hour: the color of the mixture is not darker than matching fluid K, described under the test for carbonizable substances, pages 441 and 557.

Referring to these page references we find elaborate directions as preliminary precautions, details of manipulations and a table of 20 matching fluids. Therein it will be found that matching fluid K is made by mixing 0.5 cc of the cobaltous colorimetric solution and 4.5 cc. of the ferric colorimetric solution. As to the 48 official chemicals to which this "carbonizable test" is applied the quantity of chemical used varies from 0.01 Gm in the case of Codeine to 0.5 Gm in the case of Citric Acid.

The "Co-Fe-Cu" standardized colored fluids have been the subject of 13 papers by Dr. H. V. Arny and his co-workers, notably Professor A. Taub. These fluids have stood the test of 24 years of use and afford a sample means of matching most of the colors required in chemical testing.

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ABSTRACT OF PAPER ON "RECENT PROGRESS ON COLOR PROBLEMS IN THE PAPER INDUSTRY"-L.C. LEWIS, M.I.T. COLOR CONFERENCE, July 23, 1936.

The color problems encountered by physicists in the paper industry are largely such that the physicist must know a good deal about their manufacturing, psychological, and economic sales background before he formulates the problems in a productive way. An instance of this was the problem of grading for so-called brightness (for which the more appropriate name of bluflect is proposed.)

Color occupies in general a place of second importance for the customer of this billion dollar paper industry; of first importance in a large group of papers. As a starting point for the discussion, nine classifications were made. These are the problems of producing, -

1. Bleached Pulps
2. Proper Colors for Printing Papers
3. Optimum Chromaticity for White Papers
4. Useful Gradings
5. Transparent Papers
6. Opaque Papers
7. Saturated Colors
8. Controlled Dyeing
9. Optimum Results in Hiding Raw Stocks with Coatings

The fundamental physical problem is, of course, the theory of light in diffusing media. There are in existance, at least, three theories developed around 1931, which show an interesting agreement with the facts. The one presented by Gurevic and Kubelka-Monk and developed by Drs. Steele and Judd in this country relates to the total amount of light transmitted and reflected by such media when the incident light is diffused. The agreement of this theory with facts has really been remarkable as it shows the variation of the contrast ratio with the basis weight and dyeing, also the reflectivity vs. the same variables, as well as the hiding powers of coatings. This is the more remarkable because the assumptions of the theory as to a rather fine-grained medium are so violated by the structure of a sheet of paper. Ordinary sheets of paper are of the order of 5 to 10 fibers thick; fibers are very long compared with the thickness, and cellulose is doubly refractive. Still further progress can be expected when these factors are built into the theory.

The theory of Ryde attempts to be complete in giving the distribution of both transmitted and reflected light for a variety of incident types. It must be used in the work on glassine, wax papers, etc.

We shall mention a few outstanding results on each of the nine problems mentioned.

1. Bleaching - Spectrophotometry is being used profitably; particularly at the Institute of Paper Chemistry, and will be of use in such studies as that of Braun's on methylation.

2. Printing Papers are being made whiter for the increasing use of color printing.

3. Magazine Papers, in particular, over a period of five years have been highly blued, in a procedure whose wisdom a sound psychophysical science has not yet established.

4. In grading papers for whiteness use was found for the psychophysical specification of Judd, but particularly, for the purely physical specifications such as "grading committee brigtness", daylight reflectance. A grading particularly useful for pulps has been developed by the Norwegians and is known as whiteness P.F.I.

5. Transparent Papers are not yet adequately specified because the factors of - differing transmission with wave length, and - variable angular distribution of the transmitted light - are not specified. There have been no major developments either in transparent papers, per se, or in wax papers.

6. Opaque Papers. In the field of opaque papers, on the other hand, considerable developments have used high refractive index pigments such as ZnS and TiO_2. A wealth of material exists which has not been brought under the theory.

7. Saturated Colors, representing perhaps 10% of the industry's production, call for, at least, 50% of the color supervision. Some automatic color analyzers (recording spectrophotometers) are being used in the industry to help in color matching; the attempt is being made to make brighter colors; and particularly in the British industry serious attempts are being made to grade paper's fastness to light.

8. The science of dyeing has been appreciably furthered in two directions.

a. By the very considerable advances of Dr. Rose and the Du Pont staff. This proves paper dyeing to be largely physical rather than chemical.

b. By the application of the Kubelka-Monk theory.

Coating. The past five years have seen tremendous technical advances in both light weight coatings on the paper machines with the usual coating material, clay, etc; and in the use of coatings with ZnS and TiO_2.

Conclusion - The past five years in particular, then, have shown considerable advances all along the line of the nine paper industry color problems, by the use of:

a. Spectrophotometry, particularly with recording instruments.

b. Grading (intelligent use of spectrophotometry).

c. The theory of light in diffusing media.

Much progress, of course, has been made without these tools but they are becoming of increasing importance.

EDITORIAL CHANGE

The News Letter of the Council has been edited in the past by the Secretary, first M. Rea Paul and in 1936 by R. G. Macdonald. Believing that the Council can be served best by having its main publication prepared and edited by a staff, the Executive Committee recently appointed I. H. Godlove of E. I. du Pont du Nemours as Editor-in-Chief. With him will be associated C. Bittinger as Editor for Art, D. B. Judd as Editor for Science and later an Editor for Industry will be appointed. The following pages have been prepared by the new editorial staff.

A HUEFUL TALK TO YOU

AN APOLOGIA -- OR IS IT?

Years ago, the new editor of this sheet (I. H. Godlove) aspired to be a specialist in the diagnosis and cure of chromatic ills. In modest part, these aspirations have been partially satisfied; in a way, we are still at the business. The color-urge was inherited; but it had appeared to us that a Chromatic Age was a-borning; that we in the workaday world were emerging from the drab chrysalis of grayness.

Color! The Greeks had a place for it. And so, we think, have we. As scientists, we have toyed with it; as artists, we have daubed it on our canvases; as industrialists and sensible business men, we have put it into our advertising, our products and our packages.

In recent years, these troublous times have made some of us chronically blue. Our business -- were we even scientists -- was "in the red". We were going home with the dark brown taste in the mouth. We were unable to look through the old rose-tinted glasses to see the yellow-golden flood again flowing our way. The purple depression had us contemplating black mourning for dyeing business, departed bank accounts and profits. But we took a hitch in our belts and carried on, waiting for the rosy dawn, for we lacked the yellow streak. We toned up our product, gave it a more healthy vigorous complexion, made it more attractive, put more color spice into our sales appeal.

We put color into milady's kitchen -- in her stove, her refrigerator, her cabinet and her breakfast set. We threw her old-fashioned nickeled alarm clock in the ash can and dressed it up in rose and blue. We gave her pink bed linens for her guest room; put colored soaps and cleansing tissues in her bath room, which once was all virgin white -- to match pleasantly with the enameled tiles.

We got the men to toning up to the new age too. No longer may we call only Babe Ruth, Dizzy Dean and the departed Huey Long "colorful". For John Smith and Bill Jones are wearing green shirts instead of white, and vivid ties to match. They strut the sands in their beach robes like proud peacocks. Smith has his desk set matching his office rug and its tinted walls, and Jones has harnassed the rainbow to his display room. Mr. Auto Maker takes a lick at the depression by giving Mrs. Van Millions a car lacquered and upholstered so as to best set off her Titian blond hair. The Big

House (we mean the mail-order house) has converted more of its black-and-white catalog pages into chromatic persuaders.

Some have failed to awaken to the possibilities of the Color Age, have neglected that powerful sales lever, that efficient crowbar, that beautifier of life, Color. (Pardon the sales-appeal jargon. We fear we have talked to too many advertising agents.) Some are splashing vivid red all over the advertising pages, making the color of the pictured product look sick and anemic. Some have summer drinks in torrid reds and oranges or burnt browns, not cooling colors. Some have us in constant fear of stumbling over a rock crusher depicted in delicate violet; tripping up in exquisite jewelry done in dark blue, dodging a house with shingles of a color-weight which might topple it over onto our heads from top-heaviness. On Broadway, we have been forced to cultivate color-obliviousness. But most of us have tamed the Chromatic Urge. Our catsup is being maintained of a color that makes our mouths water and our meat more savory. The flour in our kitchen bins is bleached to a whiteness that makes us enjoy the cake. We have been given beautiful new lacquers and newly colored synthetic plastics and rubber goods.

We have been made more color-conscious. We are using dyes rivalling the variegated golden browns and russets of autumn foliage, the peacock's proud plumage, the iridescent wings of the butterfly. Color in the long past has been only Nature's advertising: The flower advertising its Spring Opening to the bee and the butterfly; the pitcher-plant advertising its free drinks to suckers. Some orchids as well as parrots display colors in horrendous taste; but they get the business. Recently, man has gone into the field, with equally varied success. A world without chromatic color might be a world without much beauty -- though the French Classicists and Romanticists couldn't agree on this; but even the Greeks, whom the Classical Revivalists aped, polychromed their marble statuary. Nor is beauty now confined to nature. To call to mind the contributions of man, we need think only of the rich hues of the gorgeous gowns of our ballrooms, the vibrant play of the multi-colored lights of our theatres. From the earthy rocks man has brought forth vivid pigments; from the Viscid black tar of the coke ovens he has developed his myriad of dyes far surpassing the colors of Jacob's cloak.

But variety and beauty are not the only qualities which color has brought to us. It has had a practical influence on our daily lives and work. It is creeping into our factories, pervading our offices, our showrooms, even our laboratories. Color is a practical tool as well as an esthetic one. In the mind of man in the Machine Age it was, alas, only too often merely a powerful tool. Recently it seemed that the machine was crushing us. Today, as the Age of the Machine is rapidly merging into the Age of Science, it behooves us, the friends of Color, to inquire how we can control this power, this additional lever, color; how to make it our servant, not our master. For color applied broadcast, without judicious restraint, without scientific control, can become like a wild locomotive, a mad iron horse run rampant. The Age of Science is becoming also the Age of COLOR. With Industry and Art co-passengers, and Science in the driver's seat, we must harness the rainbow to serve our practical needs as well as to satisfy our sense of the beautiful. Industry must flirt with Art, and Art must come to Industry! And Science must not stand scornfully aloof, frowning on such human frailties; it must beam upon this radiant courtship, like a benign, conniving and blessed benedict.

Wow

But we were inditing our Apologia -- or were we? We are not long given to the modest mood. The attitude is strange and makes our joints creek. There is too much exhilarating color in the world! Nor do we hesitate to cast off shamelessly the toga pura of the Roman, that stern mantle of the scientist, to don the freer chlamys of the classical Athenian Greek. We shall forget we were ever scientists -- or were we (?) -- and seek to deck out the dry bones and solid meat of our scientific facts about color with color. We mean to wallow in the soft pleasant mud of scientific inaccuracy a little, hoping we'll be pardoned if we bathe in exactitude much more. In fact, as color scientists we must recognize that white is whitest when in simultaneous and successive contrast with black.

The scientist, you know, is a man who will spoil a good story by telling the truth! We hope to introduce a few stories about color, or colorists, and fib gleefully, if we must. We shall not wince if you damn us; we shall wail in belly-aching pain if you ignore us, if you don't read us. We were once a teacher, cajolling that most naive of all animals, the college student, into contemplating the beautiful symmetry inherent in the structure of organic chemistry amidst its obnoxious odors; and we learned that we saw most when we camouflaged the facts with a little flimsy adornment of glorified nonsense.

We are beginning the process of adulteration by propounding some questions on color and vision; title: "The Colorquery and Visionnaire". We shall answer them later -- believe it or not -- by using chiefly words of one syllable. We shall eat worms if you find the questions utterly uninteresting; but we shall not die of hypertrophy of the mortified ego, with complications, if you are able to detect, by diligent search, a chromatic lapse from rigid unbending scientific accuracy. Why not join the frog-sticking party. Turn your light our way. Impale any frog of fancy which hops too far out of the scientific puddle of fact.

We close this Hueful Talk to you with a story. You may, if you choose, search the archives to prove its accuracy. We must end somewhere. Perhaps we have been garrulous. In the future we hope not to be verbose; instead perhaps only prolix. (Verbosity, in scientific language, means many words per idea; prolixity means many ideas per subject). Oh, yes; the story! Well, the artist Whistler was berated by an artist friend for leaving his pictures in a rough, unfinished state. We hope you will not answer us as Whistler did his critic. The friend complained, in technical language: "My dear Whistler, why do you never finish?" "My dear friend", retorted Whistler, "why do you ever begin".

Yours chromatically,

The Editor.

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THE COLORQUERY AND VISIONNAIRE

N. B. In this section, which we propose to run serially, we shall propound a few questions in each issue, and in general, answer them in the same News Letter. Probably we shall ask the questions near the start, and answer them at the end. Most of them will be short; that is, even the answers; but to get under way we may have to use longer answers, involving explanations which will be made the basis of later answers. In this Letter, in order that you may have some sort of an idea as to the nature of the questions, we shall give a fairly long list of them, with the answers to one or two immediately following. In subsequent issues, we shall repeat the unanswered ones, giving only three or four with their answers, in serial order. Please remember our promise, or threat, to write in "words of one syllable". The questions:

1. Why is the froth of amber beer white?

2. What animal is near-sighted and far-sighted at the same time?

3. Why do we see only four to six stars in the Pleiades group when we look directly at it, but see more (of the weaker ones) when we look somewhat to the side?

4. Why do fishes' and cats' eyes "shine in the dark"?

5. Are the colors of cherry blossoms and beets chemical cousins?

6. There is no blue pigment in either the sky or the eyes of the Irish colleen. Why are both blue?

7. Why does smoke appear blue against a dark roof but yellowish-brown above it?

8. What is the difference between the iridescent blues of the peacock and the non-iridescent blue of the bluejay?

9. Why does a row of street lamps in a London fog seem redder and redder at increasing distances?

10. Why is the crest of a wave greener than the rest of the wave?

11. What causes dark hair to turn gray and white?

12. Why do leaves turn yellow, brown and russet in autumn?

13. How are green, hazel and brown eyes related to gray and blue ones?

14. Why is a piece of cloth darker when wet than when dry?

15. What is "nature's daylight-saving process?"

16. How can the chameleon change the color of his skin to protect himself?

17. If the pupil of the eye may be called the hole in the doughnut, what is the doughnut and its function?

18. How do colors look to the color-blind? To the partial and total color-blind? How do we know?

19. Why couldn't the "eagle-eye" of many birds take in the movies?

20. Does a square inch of white look larger than a square inch of black?

21. How can we explain the "silver lining of the cloud?"

22. How do the dyers of changeable silk resemble the painters of the Impressionistic school?

23. When moonlight is seen on water, why does it seem glittering near us, lustrous farther out, and quietly shining at a distance?

24. Why does the crescent of the new moon look larger than the rest?

25. What did the artist Delacroix mean when he said, "Give me mud, and I'll paint the skin of a Venus?"

26. What is the nearest distance of two small objects that the eye is capable of seeing separately?

27. Why are nickel coins the color of nickel, although 90% copper?

28. In most persons, which eye is the master, which the servant?

29. Can fish see the brilliant colors of the fisherman's bob?

30. By what optical method did Aristophanes, playwright of the fifth century B. C., have a character get out of paying a note?

31. Why does the moon appear larger when near the horizon?

32. An artist was worried by constantly seeing colored circles which were growing more vivid and larger. Was this good reason to fear for his eyesight?

33. Why, just before daybreak, do red flowers appear black, and the grass a nondescript gray, while blue flowers have their normal beautiful color?

34. Why must the lens of the eye become flatter to see a far object and fatter to see a near one?

35. Why does not binocular vision give double brightness?

36. Do any animals have two pupils in each eye, like a pretzel instead of a doughnut?

37. What animal winks upward?

38. Can earthworms see two particles of food an inch apart?

39. Do radio waves travel faster or slower than light?

40. Why was man at one time "eater by day, and eaten by night?"

41. Do vultures chiefly smell their food, or see it?

42. How early in history did the ancients learn that light rays do not run out from the eye like antennae and come back with information?

43. If a light-colored piece of crockery decorated with a dark design, is heated to incandescense, which part, decoration or ground, will appear brighter?

44. In what kind of light are all normal persons near-sighted?

45. At what time of our lives do we normally see double?

46. Why did Aristotle think there were seven and Friar Roger Bacon only five "colors" in the rainbow?

47. When does light "bend around corners?"

48. What animal is all eye?

49. Do ultraviolet rays "prefer blonds" -- in their therapeutic action?

50. What portion of our eye has an individual, and what portion a "party line" connection to the brain?

51. Is the vision of birds better than that of men in every way?

52. Why are thin layers of indigo carmine solution blue, thick layers red?

53. In what liquid would quartz look opaque like white-lead; and in what liquid would white-lead be tranparent like quartz?

54. How does the intensity of moonlight and starlight compare with sunlight? Hundreds to one, or millions to one?

55. What was Friar Roger Bacon's optical scheme, in the 13th century, for preventing war?

56. Why do the neck feathers of pigeons and peacocks change from red to green or green to purple as we tilt them, and disappear when wetted?

SOME OF THE ANSWERS.

Question 1. Beer is said to be the beverage of the bourgeoise; but beer itself like dyes and paints, is fastidious in its appetite for energy. These materials are colored because they are energy selectors, or "wave-length selectors"; when white light strikes them, they select in a finical manner, only certain waves for absorption into their substance. They reject other waves, as fit only for the consumption of "common" substances, like lampblack, which do not satisfy their desire to convert light energy into the heat of the molecular dance. We see the rejected part as transmitted light if the source and our eyes are on opposite sides of the beer; as reflected light if on the same side. If of "white" light nearly all the energy of all wavelengths is absorbed, the color seen is black; if all is reflected, the color is white; if most is reflected, a near-white. If only about a fourth of the light comes to the eye (3/4 absorbed), the color seen will be neither light nor dark, but about medium. There are complications (and we have been a trifle inaccurate), but "why bring that up" here. In the present case, if the material devours about equally light of all wave lengths, the color will be a medium gray; but if it selects from the white light chiefly the short rays, the eye receives the long ones, which cause the beholder to see red (not figuratively, but actually), or perhaps yellowish-red or orange; if the substance selects only the longer wriggles of the light energy coming to us, say, from the empyrean sphere, then the color is blue. The solution of the dye, crystal violet, is purple because it absorbs the medium waves, which give rise to a green sensation, while malachite green does not like these as much as the longer and shorter ones. The dye para red rejects such a preponderance of long waves that, even when it is mixed with several times its weight of white materials of bourgeois appetites, it gives vivid red paints. The red, blue and violet coloring matters of flowers have also delicate energy-appetites. The food dye, napthol yellow, is somewhat less finical; it absorbs all but the yellow and some red, orange and green. Beer is slightly less fastidious still; it will take a goodly portion of all wave lengths, but transmit predominantly the yellow.

So far we have "explained" (1) only the yellowness of beer, although we have found out, en passant, the basic reason for white. Why the bird-like appetite of the froth, rejecting nearly all energy food? The explanation lies in the unsubstantial nature of the froth, in the myriad of small bubbles. The surface of each of these is a miniature partial reflector. Even very transparent glass is a partial reflector, as we know from the reflections in automobile windows. Each minute bubble absorbs only infinitesmally; and absorption is required for the yellowness. As we subdivide a liquid the relative area of surface is increased more and more, and we afford a chance for more and more reflection before there is much absorption. This is the reason for the whiteness of clouds, white hair, enamels, cod liver oil, snow and even the petals of the Easter lily: -- though at first thought the connection between beer and Easter lilies is not obvious. Clouds are a dispersion of fine water drops in air; foam or froth the reverse. Snow comprises ice crystals and air. In lily petals and white hair there are air cells. Enamels have tin oxide in a glass. Two rather different materials are required, because the proportion of light reflected depends on the relative speed of light in the two substances. As every one knows, beer and air are quite different. We will talk about the "cause" (1) of the absorption in answering a later question.

(1) The kind of "explanation" which we are attempting here of course merely states the facts in a different way. It does not deal with supposed primary "causes" which is the business of the metaphysicist.

Question 2. The common house-fly has two large dark-brown compound eyes, each composed of about 4,000 eye-units for distant seeing (at a few yards). It has also three single eyes, forming a triangle with point downward, between the compound eyes. These are for near seeing (at an inch or two). One set is "near-sighted", the other "far-sighted". Neither set will focus for the distance cared for by the other.

Question 3. When dark-adapted, the eye is relatively blind in its fovea (the center) where the image is formed when we look directly at an object ("fixate" it). This fact was discovered by the Dutch occulist, Donders, in 1880. We can do better by looking somewhat eccentrically, as is well known to astronomers. According to legend, the seven daughters of Atlas were transformed into this group of stars, only six of which are commonly seen. The last Pleiad, according to the legend, concealed herself for shame for having loved a mortal; but the telescope, which does not know the legend and perhaps remains unsympathetic, reveals her.

COLOR COMBINATIONS

We have received an interesting paper by Elysbeth C. Allen and J. P. Guilford of the University of Nebraska, entitled "Factors determining the af-

(1)

fective values of color combinations". This continues the study of the agreeableness of single colors and their combinations previously reported by Guilford in papers published in 1931 and 1933, which the editor recalls reading with much interest. A Letter Circular on color harmony written at the Bureau of Standards remarked that authorities in this field were not in good agreement; in fact, some of the rules formulated for the prediction of good combinations are in contradiction to the conclusions of other writers. Part of the unsatisfactory state of this field can no doubt be attributed to failure to calibrate the color samples presented in terms of rationally graduated color scales. Also, the "light blue" of one writer may have been considerably different from the "blue tint" of another. The present authors have used Milton Bradley papers calibrated by relating them to the scale of the Munsell Book of Color.

One of the chief questions which Guilford and co-workers have investigated is whether the pleasantness of a combination of colors is largely dependent upon the pleasantness of the individual component colors. The answer is in the affirmative; and Guilford has stated a quantitative law for the prediction of the pleasantness of a two-component color combination. The authors confirm, especially for women, the rule most commonly stated by writers on color harmony; one which the editor, writing in 1935, called the Rule of Avoidance of Intermediate Hue Contrast. This states that, other factors being equal (with an exception noted below), colors of contrasting hues or of neighboring hues are more favored than those of medium hue contrast. Allen and Guilford called "contrasting" those hues differing by more than 30 steps on the Munsell 100-step scale (the editor in his article, based on similar experiments, using 35); they define as neighboring hues differing less than 10 steps. They do not confirm the rule which we called the Rule of Substitution of Contrasts, one for another. This principle, when applied to decoration, for example, states that when neighboring or "analogous" color schemes, which are usually restful and easy to handle, are used, much saturation and lightness ("value") contrast may be introduced; the more striking but more difficult "complementary" schemes must avoid garishness or harshness by shunning great lightness or saturation contrasts. Commonly, the latter are avoided by using "accents" (small areas) of vivid color with larger areas of weaker color. In practice, we frequently find small spots of vivid "warm" color set against larger areas of cold grayer colors. The authors, however, find that large differences in lightness are favored, especially by men, regardless of hue contrast. Perhaps part of the disagreement lies in the fact that the authors called "small" lightness differences up to two Munsell value steps, while the editor's experimental small differences was much smaller, influenced, no doubt, by the fact that several great painters have accomplished extraordinary results with very small lightness contrasts; though to be sure, in pictorial art extreme lightness differences are usually greater than in decorative art; and gradual lightness contrasts, but rarely abrupt ones, may reach five value steps.

Since the authors have considered color combinations wholly apart from their application they did not, of course, consider a broad principle which may be called the Rule of Appropriateness (or fitness). The production of dominant moods through the choice of colors, having certain associations for most people, must be considered. The hues must not be incongruous with the desired mood; for example, a cold one can be produced through predominance of blue, or a gorgeously warm one in a scene of oriental pageantry or Spanish revelry, through the liberal use of red and yellow. The authors are sensibly eliminating many variables by sticking to simple color systems. We may proceed most felicitously to the broader aspects of color harmony from a sound foundation of scientific experiment such as theirs. After all, the basic principles for this broader attack are well established in common sense.

The keynote of good composition is the securing of order and unity in the midst of variety. Variety is the spice of life, even in design; but unity is its food; both must be used in moderation. Variety, contrast and vividness are necessary to attract and arouse interest; but it is a sense of unity, order and congruity which impresses favorably and creates and satisfies moods and desires. Variety and contrast overdone is chaotic, or at least disturbing and unpleasant; unity overdone is uniformity or at least monotony. Fashions, styles and the schools of painting are some expressions of the need of variety. The existence of the principles of design and harmony is an expression of the need for a sense of order. The mark of good design results from knowing where to stop between these extremes.

Finally, we take the liberty of suggesting to the authors that their experimental data and methods can be used to test the validity of a principle of harmony which we enunciated in the third article (2) of our series, and called the Rule of the Natural Sequence, which appeared to come out of our experiments. This states that there are certain natural sequences of lightnesses for the most saturated colors of the successive hues of the spectrum as well as in the common pigments; and combinations opposed to these, as dark green-yellow and light blue, are unnatural and unpleasant. This is perhaps one manifestation of an inherent pleasure arising in satisfaction of a sense of order.

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(1) The three papers of Guilford and co-workers are: American Journal of Psychology; 43, 469-78 (1931); 45, 495-501 (1933); and 48, 643-48 (1936).

(2) See I.H. Godlove, American Painter and Decorator, 12, no. 7, 25-28 (1935).

HE'S A GOOD EGG AND COLORFUL.

(Egg Quality is not Yolked to Yolk Color)

We must rate Mr. Paul Mandeville of Chicago, a "good egg" and we are sure he must lead a colorful existence; for besides his kindness in sending us an interesting article on egg-yolk colors, we find that he is vice-president of the Institute of American Poultry Industries and Secretary of the National Advisory Committee on Research in subjects related to eggs and poultry, including their color.

In a short article illustrated with a double page in color the October, 1936, number of the U. S. Egg and Poultry Magazine gives us the story of color in eggs. We learn that certain popular ideas on the subject have no substance; they are mere empty shells. It is known that the color of the shell is determined by the breed of the bird. It was also generally believed that there was a relationship between the color of the shell and the color of the yolk. It was thought that all eggs with dark brown shells had orange yolks while white-shelled eggs had pale yolks. But research has shown that either the brown-shell meat breeds or the white-shell Mediterranean breeds (Leghorns, Minorcas) may lay eggs with either light or dark yolks.

It all depends on the hen's food. If she consumes feeds rich in the natural coloring matters known as xanthophylls, she lays rich orange-yolked eggs. Among such xanthophyll-rich feeds are alfalfa, green grass and yellow corn. After the hen has been denied these feeds, as in winter, she craves unusual quantities, and, gaining access to them, produces eggs with dark yolks. If the color reproductions in the magazine are faithful, the yolk colors range from about Munsell Y 9/1 to 2 YR. 5.5/6.

Consumers may therefore feel assured that, if two eggs of very different yolk colors appear on the same plate, it means merely that the two hens which laid them had access to different color-producing feeds, a common occurrence even on the same farm. The color of the yolk is not related to the color of the shell.

SPACE PERCEPTION.

An Introduction to Space Perception. By H. A. Carr. New York. Longmans, Green and Company, Ltd., 1935. Pp. xi-413.

More than seventy-five years have passed since Lotze, Helmholtz and Wundt undertook to formulate the problem of space perception. This problem has since become one of the most fruitful and perhaps the most important of all the problems of experimental psychology. Nevertheless, the problem of space perception is so intertwined with other aspects of sensory function that it has hardly achieved the degree of autonomy that is fully warranted in view of a voluminous experimental literature. Timely, indeed, is this authoritative English text devoted exclusively to these materials.

The work evinces a distinctly modern cast. One finds here a treatment that is not weighed down by extended historical and encyclopedic documentation. The functional approach is consistently maintained, and the problem of efficiency is kept in the focus.

The general problem is oriented primarily in respect of remote objects (p. vi.) The author's objectives are to indicate the various modes of apprehending spatial relations, to specify the factors upon which such functions essentially depend, and to set forth the conditions under which they optimally determined. Representative studies which bear upon the various phases of the problem are summarized and critically evaluated.

The book comprises a short Introduction (pp. 1-6). ten longer chapters (vide infra), and Subject - and Name - Indices (pp. 407-413). In two cases, a heading is allocated two chapters; otherwise, the subject matter of different chapters is essentially distinctive. Nevertheless, the successive chapters are bound into a unity by a thread of continuity: to wit, a motor (proprioceptive) theory of space perception, which usually is explicated after a presentation of experimental data. This theory specifies that spatial relations are apprehended in terms of motor adjustments (manipulations) in respect of objects. Adjustment for each point in the spatial field is distinctive and is the basis of a specific locality reference ('local sign'). It is in terms of the efficiency with which these adjustments are made that the capacity of the organism for apprehending spatial relations may be determined.

That space is a geometrical abstraction -- a 'conceptual' rather than a perceptual matter -- is stated at the outset. The senses act cooperatively in apprehending spatial relations (chapter 2; pp. 7-58). However, vision is said to be primary; it is the single receptor-system in terms of which these relations are most accurately determined, and it is dominant over hearing in localizing with the aid of pseudophones. The cooperative action of the senses in this context is acquired; a new functional relationship is readily established between vision and somesthesis (proprioception) after the customary one has been disrupted by means of a lens that shifts visual relations in a definite way.

Chapter 3 (pp. 59-91) is devoted to the inverted retinal image, or optical inversion, mystery. It is indicated that the correlative fact of horizontal inversion has been generally ignored. The enigma in this much discussed problem has its basis in a dualistic distinction between a physical and a visual or psychological object, the latter of which has no existence independent of and apart from the perceiving subject.

The treatment in chapters 4 and 5 (pp. 92-158) concerns the auditory perception of space. The author here attempts to distinguish between visual and auditory perception of space; i.e. in terms of vision spatial relations are sensed but in terms of audition they denote meanings. The latter is said to signify a relationship between an auditory object and a visual and somesthetic object. However, the distinction is one of degree rather than one of kind, since visual relations of space denote meanings between a visual object and a visual and somesthetic object.

Chapter 6 (pp. 159-194) is primarily concerned with the fact that excitations in the two corresponding areas in the binocular relation entail like localizing responses and signify a common locality reference, while excitations in non-corresponding areas refer to objects at different spatial positions. Chapters 7 and 8 (pp. 195-228 are devoted to visual perception of direction.) Knowledge regarding the latter problem is less definite and precise because it is more complex and has not been investigated so thoroughly. In chapter 10 (pp. 336-358) the topics of continuous and discontinuous movement are summarized within the bounds of a short paragraph apiece, and the topics of relativity in the perception of motion, objective and organic criteria, and after-effects are discussed at some length. The last chapter (pp. 359-405) is concerned with linear and a real aspects of visual perception.

A treatment which makes efficiency the central problem has a very definite bearing upon the problem of learning. The latter dovetails with the problem of space perception in two distinctive ways: (1) the rivalling claims of nativists and empiricists need to be evaluated in order that the scope of the bearing of the problem of learning in the present context may be specified, and (2) the course (character, rate, etc.) of improvement in efficiency needs to be traced in connection with such aspects of the problem as manifest the property of acquisition.

The first of the phases of the learning problem, that concerning the distinction between native and acquired aspects of space perception, is one of the salient considerations of the present work. It receives attention in a number of connections. The reader may be a bit surprised to discover that the author leans so strongly toward nativism at several points. This is illustrated in the specification that the common locality reference of corresponding areas in the binocular relation is 'inately conditioned'. Although comment is added that "the strength of the connection may be materially influenced by experience" (p.   ) this commitment has the effect of shifting learning to a role of secondary importance.

The second, the developmental, phase of the learning problem receives treatment by implication at least in such a context as that regarding the establishment of a new functional relationship between vision and somesthesis (proprioception) when lenses are worn. However, this aspect of the learning problem does not receive the careful attention that it deserves, and possibilities are not seized upon to indicate instances in which developmental features may presently be revealed. Thus in the last chapter, pronouncement is made that size and shape must be taken for granted as a given datum of experience (p. 361). A different treatment could have indicated that the manner in which these characteristics emerge from non-spatial components has not yet been clearly revealed, however, it is conceivable than in due time it too will be shown to be a function of learning.

The author's decision to restrict reference largely to English sources is well justified. Specific references to the significant contributions of Lotze and Wundt in such a work is a matter of choice and not of requirement. Besides, statement is made in the Preface that little use was to be made of the wealth of German literature. However, the neglect of such other German sources as are now readily accessible in English is not so easily comprehended. Too, it cannot be taken for granted that the (American) functional and the (German) configurational approaches which converge upon this problem are mutually exclusive. The laws of spatial grouping and other factual data are not specifically considered in the very contexts in which they have a natural setting. A more definite comment in the Preface could have dispelled much wonder as regards this indifference.

These critical comments are here set forth for the purpose of indicating points at which the reviewer believes the treatment might have been made more representative; however, the points at issue are not to be construed as in any serious way defeating the end for which the book was designed. The work is, indeed, what it purports to be -- an introduction to space perception. For this purpose, it is very suitably adapted. As the only authoritative (modern) text on the topic, it embodies points of high merit. Chief among these are the functional approach and the designation of efficiency (the adequacy of the organism in responding to the environment) as the central problem of perception.

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A member of the Council has written the Secretary as follows:

"Will you kindly let me know whether or not you have any list showing what color measuring instruments are in use by members of the Council."

Please send pertinent information to R. G. Macdonald, 122 E. 42nd Street, New York so it may be passed along to the inquirer.