INTER-SOCIETY COLOR COUNCIL
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News Letter Committee:

Faber Birren
I. H. Godlove
Deane B. Judd
Dorothy Nickerson

I. H. Godlove, Editor
General Aniline & Film Corp.,
Easton, Pennsylvania

Dorothy Nickerson, Circulation Manager
Box 155, Benjamin Franklin Station
Washington 4, District of Columbia

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Address the Circulation Manager

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NEW INDIVIDUAL MEMBERS

We welcome the following as individual members of the Inter-Society Color Council, newly elected at a meeting of the Executive Committee held June 16-17, Washington, D.C.:

Philip J. Herbst, RCA, Camden, New Jersey, interested particularly in color problems in television, member of the Institute of Radio Engineers;

Mrs. Doris Burke Lloyd, Baltimore, Md., Interested particularly in a Duodecimal Color Notation, also in the use of color in apparel and design, member of the Duodecimal Society of America;

National Aniline Division, Buffalo, N.Y., Attn. Mr. S. M. Lazarus, interest is for Library - Personnel;

Carl P. Rumbaugh, Southampton, Pa.; whose work deals with wallpaper, paints, fabrics, etc. Mr. Rumbaugh is interested particularly in color and design as applied to masses of people, industrial, and public places. He lectures on the subject "Color, let's understand it."

Elizabeth Wentworth, New York City, interested in psychological and creative work for many years; her work on color relates to "personalysis" and deals principally with the effect of color on the appearance of the individual; particularly interested in color problems in the field of fabrics for wearing apparel; color facts helpful to home makers; also psychological problems in the use of color in hospitals, etc.

Walter A. Woods, Sparta, New Jersey, interested in psychological and creative work in color, first became interested in color problems in 1938, dealing principally with unity-variety continuums. Stoelting is now publishing his color aptitude test. Mr. Woods has been connected with the Pratt Institute since 1947 doing research in color with artistic aptitude. He is a member of APA, interested particularly in problems of color perception (as distinct from color sensation); in color aptitude; interrelationship of sensation and symbolism in perceptive processes; intent in the use of color as related to a unity-variety concept.

WASHINGTON AND BALTIMORE COLORISTS

A very successful meeting of this group was held in Baltimore on May 16 - about 33 members from Washington driving over in groups for a full afternoon and evening program. The group met at 2:15 P.M. at the Hobby Shop of the Pemco Corporation, one of the country's oldest, largest and most progressive producers of porcelain enamel frit, the basic material for porcelain enamel. Pemco also manufactures the color oxides added to the frit to produce colored porcelain enamels. Through the courtesy of Dr. Spencer-Strong, members of the group were taken first through Pemco's research laboratories where they saw equipment used for development of new frits and colors. The equipment in the physical laboratory was of particular interest - it included very up-to-the-minute models of spectrographic, X-ray, and spectrophotometric equipment. From there the group went across town to the Pemco plant where operations are automatic to an unusual degree. Pemco is the pioneer of wholly continuous, completely automatic smelting, and has recently made improvements in their six-unit battery. The 10,000 pound harding mills produce approximately 25,000 pounds of powdered frit a day. The pottery arts supply manufacturing division and the control laboratory and customer service laboratory were of particular interest. Mr. H. E. Craven, plant superintendent, took care of arrangements for the plant trip, providing one of their younger staff members as guide - and a very well informed one! Dinner arrangements were made for the group at Haussner's, nearby seafood restaurant. Several members joined the group at this point.

After dinner, through the courtesy of Dr. W. R. Garner, Director, Psychology Department for the Johns Hopkins Institute of Cooperative Research, the members were taken on a tour of inspection of some work in progress. The hosts were Dr. H. D. Baker, Mr. J. C. Franklin, and Dr. R. M. Hanes. Each demonstrated and discussed informally that part of the color program with which he was associated: applications of colorimetry to problem of color contrast; effect of color on apparent size; and investigations regarding the color-distance phenomenon. It was a full program, one thoroughly appreciated by the Colorists. Chiefly responsible for arrangements are Francis Scofield, chairman of the Program Committee, Joseph C. Richmond who suggested and made the arrangements with Pemco, and Blanche R. Bellamy, who made the arrangements with the Institute for Cooperative Research.

CALIFORNIA COLOR SOCIETY

The Second California Color Society Exhibit, "Color for Today and Tomorrow," was held from May 24 to June 6, Mondays through Fridays at 9:00 to 5:00, at Art Center School, 5353 West Third, Los Angeles. This was an exhibition in the fields of architecture, painting, interior design, ceramics (including enamels and porcelains, fabrics, wall papers, photography, etc. On the opening evening, May 24, there was a short surprise program featured by an "audio-video color abstract interpretation" of Beethoven's Moonlight Sonata. This film, completed only four hours before showing, was made by Frank Collins and Donald Meyer; musical interpretation was by Agnes Nehaus, with Albert King (who also arranged the exhibition) as advisor, the film being sponsored by the Color Department of the Art Center School. At the meeting, presided over by Dr. C. L. Graham, vice-chairman, Herbert Palmer spoke briefly on the aims and purposes of the Society and Lorser Feitelson described the paintings. We regret that space does not permit our detailing the interesting check-list of the exhibits, sent to us by Louisa A. King, secretary. The list included 75 items. The letter from Mrs. King indicated that Professor Harry Helson, who will be at U. C. L. A. for the summer, will speak to the Society on July 19 on the subject "How Many Color Dimensions?"

A dinner meeting of the Society was scheduled for 6:00 P.M. June 28 at the Taix

Restaurant, 312 East Commercial Street, Los Angeles. The speaker of the evening was to be Mr. William Manker, who was to tell about his color work for the House and Garden Pace Setter House and Price Setter House for 1949 and 1950.

COLOUR GROUP OF THE PHYSICAL SOCIETY

The 53rd science meeting of the group was scheduled for June 14, with a paper entitled "Foveal Colour Sensitivity" to be read by Dr. L. C. Thomson of the Vision Research Unit of Imperial College of Science and Technology and the Institute of Ophthalmology. A visit to Kodak Limited, to see work connected with color, was announced for June 28. Following the suggestions made at the Science Meeting on Colour Systems, held February 15, a subcommittee has been appointed to review the present situation regarding systems of color description, to investigate the desirability of adopting a standard system, and to recommend any action which could be taken.

WILLIAM F. LITTLE TO RECEIVE AWARD

The 1950 Gold Medal of the IES is to be presented formally during the IES National Technical Conference at Pasadena, California, August 21-25 to William F. Little. It is being awarded for "meritorious achievement conspicuously furthering the profession, art or knowledge of illuminating engineering." Mr. Little was an active member of the Inter-Society Color Council in its earliest days; he is a member of several ISCC member bodies, the Illuminating Engineering Society, of which he was president (1930-31); the Optical Society of America; and the Society of Motion Picture and Television Engineers. For many years Mr. Little has been in charge of photometric work of the Electrical Testing Laboratories, Inc.; in this field he has contributed a great deal of basic work, particularly during the early development of the science. He is held in great respect, admiration, and affection by all those who know him. We not only congratulate Mr. Little, but also the I.E.S. for having selected him as the recipient in 1950 of their Gold Medal, highest honor that is given in the field of illumination.

TELEVISION COMMITTEES

From the April Journal of the SMPTE: In order to eliminate duplication of effort, which results when engineers serve on committees of more than one organization working on the same subject or closely related ones, the Society of Motion Picture & Television Engineers, the Institute of Radio Engineers, and the Retail Manufacturers Association have under discussion a program for the coordination of television projects. Overlapping committee rosters may be replaced by interlocking memberships. At any rate some plan will be drawn up whereby a minimum of co-committee effort will result in keeping all concerned posted on current progress.

I.E.S. RESEARCH SURVEY COMPLETED

The Illuminating Engineering Society has recently completed a survey of research on light and vision now being conducted in the colleges and universities of the United States. Published under the title "Summary of Contemporary Research on Light, Vision and Visual Environment," a 15-page resume reports the results received from 90 of the 123 leading educational institutions whose presidents were approached for information in this field. The following data are listed for research recently completed, now underway or about to begin at 43 universities: nature of research, department conducting it, and (in some cases) names of researchers. This bulletin was prepared by the I.E.S. Research Committee charged "to survey and report on all significant research dealing with the application of light and lighting and its effect upon the performance and comfort of human beings...." Such research embraces several fields including psychology, physiology, biophysics, ophthalmology, optometry and electrical engineering.

The publication of this information should go far toward comprehensive coverage in the field and the elimination of duplication, as well as furnishing guidance to a systematic study of the many problems yet to be solved. Copies of the Research Survey are available without charge from the illuminating Engineering Society, 51 Madison Ave., New York 10, N.Y. The Committee is now taking steps to enlarge the coverage to include the entire English-speaking world. Also in the offing is a survey of visual research being conducted by industrial agencies in the U.S.A. and Canada.

NEW COLOR TECHNIQUE SHOWN IN ROCHESTER

An exhibition of forty color photographs made by a technique that offers a new medium for artistic expression opened on May 10 at George Eastman House, Rochester, N. Y. The exhibition, "Derivations from Color Photographs," is described as a new application of photography; and the Eastman House showing is the first public display of color photographs made by the technique recently announced by the Eastman Kodak Company.

The color prints were made from transparancies by a method which gives the photographer an almost infinite variety of color and line control. They use the well-known methods of photographic printing, but in the process, color brightnesses of a transparency are reduced to nearly constant value. Then in the final color print, the edge contours are photographically emphasized.

Ralph M. Evans, superintendent of Eastman Kodak Company's color-control department, where the process was developed, describes the process as a modern art form: "Those who have dismissed the merits of color photography as an art form have often pointed to the exactness of color photographs as their chief reason for disqualifying it. The new technique provides the color photographer with the interpretative medium critics have claimed to be absent." The 'derivations' technique is expected to have considerable application in the advertising and design fields.

All photographs in the exhibition are the work of Miss Jeannette Klute, a photographer for the visual-research laboratory of the Eastman Kodak Company. The new color technique was developed by Miss Klute in association with Mrs. Dorothea Petersen, a color technician at the laboratory, under the direction of Ralph M. Evans.

I.S.C.C. PROBLEM 15 and 16 ESTABLISHED

At a meeting of the I.S.C.C. Executive Committee held June 16-17 the following problems, turned over at the annual meeting to the Problems Committee for recommendation, were favorably reported by Dr. M. J. Zigler, chairman of the Problems Committee. The following action was taken:

Problem 15: Definition of Color Terms. A new committee shall be set up to follow up on the Survey of Color Terms report, to provide a medium for encouraging member bodies to work with the Color Terms report, and to obtain as much agreement as possible on the wording of definitions intended to have a similar meaning, encouraging Member Bodies thereafter to publicize, adopt, and use such defined terms so that the present confusion in terminology may be reduced. Richard S. Hunter of the American Ceramic Society delegation was appointed chairman of this committee, with Messrs. Judd, MacAdam, Newhall, Scofield, and an IES representative, to serve on the committee with such other members as the committee chairman finds necessary or desirable to best further the purposes of this problem.

Problem 16: Standard Methods for Mounting Textile Samples for Colorimetric Measurements. A committee shall be set up to study and report upon this problem as it is outlined in a letter of March 10 from J. L. Barach (Chief, Physical Research Laboratories, Alexander Smith Carpet Company) to Fred Simon, chairman AATCC Color Committee, and in other correspondence and discussions by Stearns, Barach, and Simon with the ISCC secretary. J. L. Barach was appointed chairman of this committee.

COLOR REPORTS FROM NATIONAL BUREAU OF STANDARDS

Color Charts: A Descriptive List: Color Harmony, An Annotated Bibliography; and Colorimetry, NBS Circular 478, by Deane B. Judd, provide three very useful additions to the literature on color. The first two are Letter Circulars 986 (13 pages) and 987 (21 pages), dated May 10, 1950, which supersede previous LC 809 and 525. These reports are multilithed and are intended for use by the NBS staff in answering inquiries. They may be obtained without charge by writing for them direct to the National Bureau of Standards, Washington 25, D. C.

Colorimetry, NBS Circular 478, a printed bulletin of 56 pages, (144 references) fills a long-felt need for a brief but authoritative discussion and handbook of modern colorimetric methods as practiced at the National Bureau of Standards. Dr. Judd has prepared a report that undoubtedly will find use as a text in many college and private laboratories. Copies may be purchased from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. at 30 cents each. With its equally authoritative companion report on Spectrophotometry by Dr. K. S. Gibson (NBS Circular 484, 44 pp. September 1949, reported in the May 1950 News Letter, price 25 cents domestic, 30 cents foreign), the techniques and data resulting from the National Bureau of Standards extensive experience in colorimetry and spectrophotometry are now available in brief, clear, and authoritative texts for the very low combined cost of 55 cents to anyone who will take the trouble to order them from the U. S. Government Printing Office. We urge that all ISCC delegates and members take that trouble - they will find it rewarding. D. N.

FADING OF COLORED MATERIALS

In the March 1950 number of Illuminating Engineering there is an article by A. H. Taylor and W. G. Pracejus of interest to many ISCC groups: Fading of Colored Materials by Light and Radiant Energy (pp. 149-151). References are given to earlier reports in the past 25 years from the Lighting Research Laboratory of the General Electric Company. Ultraviolet energy is often blamed for much of the fading of colored textiles, and the authors therefore present a table of relative ultraviolet for several illuminants, and a report of tests made on a series of textiles. They conclude, after filtering out ultraviolet by use of Wratten 2A, that fading of colored textiles is principally due to radiant energy in the visible spectrum. As a result of their many years of research they report a series of seven generalizations that they believe represent average results. Among these: The reciprocity law (foot-candles-time), applied over a practical range of artificial illumination; temperatures 85 to 120°F do not appreciably influence rate of fading, but at 150°F the fading rate is approximately double that of 85°F; filtering out ultraviolet in daylight does not appreciably reduce the rate of fading; relative exposures in footcandle hours to produce equal fading have the following approximate ratios:

Midsummer sunlight plus skylight	1.0
North skylight	0.5
Tungsten-filament lamps (500 watt)	1.8
Fluorescent daylight lamps	1.7

Tests were made of exposures of meats and cigars under tungsten-filament and fluorescent lamps; Bologna, one of the meats most susceptible to color change by light, measured before and at intervals during the test on the spectrophotometer, showed identical results under the two sources for equal footcandle-hours of exposure. As for cigars in display cases, a series of continuous exposure of two weeks to three months showed that it took an average exposure of 40,000 footcandle-hours to produce a just noticeable color change, and double this exposure to produce an easily noticeable change. Accelerated fading tests using quartz mercury arcs, probably owe much of the change to energy shorter than 300 mμ, energy not present in sunlight reaching the earth's surface. Germicidal lamps are rich in energy in this region, and tests using them indicate that textiles which will not fade under them have also been found to be highly resistant to sunlight. They mention that they have not studied fading of plastics, that they are likely to vary in regard to depth of ultraviolet penetration, hence in some cases such fading may take place very near the surface.

ISCC-NBS COLOR NAMES

The Editor has had occasion to study the ISCC-NBS Color Names, as revised recently in principle by the ISCC Color Names Sub-Committee and in detail by the National Bureau of Standards, using the Committee's mimeographed 1949 report as a guide. The main purpose was to see how efficiently or economically the revised system works, in comparison with earlier revisions, along with the obvious much increased understandability for the layman. The following statistics were obtained by the Editor by a study of more than 900 common color names, like Turquoise blue, and Coral red, exemplified in Maerz and Paul's "Dictionary of Color" and in the 9th Edition of the Color Card of America and the U.S. Army Color Card standards issued by the Textile Color Card Assoc. of the U.S. and as judged by the measurements published by the National Bureau of Standards (J. Opt. Soc. Amer. 36, 128: 1946). In the case of the latter two groups, the ISCC-NBS names were obtained from the published measurements, as before, but using the revised boundaries as recently adopted by the ISCC.

In the case of the remaining color names, taken from the Dictionary of Color, the average of from one to five determinations of the Munsell notations of the colors was utilized. The averages included notations obtained from direct comparisons and published by Dorothy Nickerson (as part of the ISCC-TAPPI Symposium on Color in February 1947). The other averaged determinations were made by Mrs. Genevieve Reimann, the Editor and in some cases one or two other persons in 1930-34 as a basis for the definitions of color names appearing in Webster's New International Dictionary. For this purpose the Editor used three copies of the M & P Dictionary of Color, cutting out the small color chips from two copies so as to obtain a practically disappearing dividing line when comparing them with the Munsell colors. The third copy was also used frequently, but by the mask-isolating method utilized by Miss Nickerson. These precautions were taken because some differences were found between the different copies of the Dictionary of Color, particularly among the darker colors where there was high "reflex" (plates 7, 8, 15, 16 etc.).

It should be stated, however, that on the whole these various copies agreed well. Moreover, in general, determinations of M & P reproductions of the TCCA colors agreed well with those obtained (with proper precautions) directly from the textile samples. It may also be stated that in general, D.N.'s determinations of Munsell notations, obtained about 1946, agreed surprisingly well with those of the Editor, taken 15 years earlier. The exceptions, as was to be expected, were mainly in the hue determinations when the chroma was very low, and in chroma determinations when these were very high, requiring extrapolation beyond the chromas of actual Munsell samples.

Turning now to the statistics, it is necessary to state that they are all approximate because of borderline cases counted two, three or even four times. Allowance was made for these by division by 2, 3 or 4, respectively; but the figures were rounded to the nearest half in each of the 270 classes or types of definition corresponding to the pockets into which the color solid was divided by the subcommittee. The borderline cases require longer definitions; for example, Baby pink (TCCA) is a "Light pink to light yellowish pink," and is counted as of six words in length in the following data, though the description may be shortened to "Light pink to yellowish pink." In all the following data, where a number is followed by one in parenthesis, the latter or smaller one is the number without including borderline cases, the former or larger one is that including borderline cases (with appropriate divisions). The number of cases not on borderlines was 792, the number on the border of two pockets was 110, on the border of three was 8 and on the border of four was 2. It was found in the last case, that up to 14 words were required for definition, but the average for all borderline cases was about six; and the average for all the 792 non-borderline cases was 2.5 words. The total of 792 + 110 + 8 + 2 is slightly higher than the number of names actually examined, because of the rounding off.

It was pointed out by the Editor in 1932 that in the earliest editions, if the 600 most common names were used to designate the 600 pockets of the ISCC Color Name System as then existing (using only 12 words), then common names existed for only a third of the pockets. There were no names for the remaining two thirds. In the present revision, using over 900 names for 270 pockets, there are still no common names for 88 pockets or for 70 if we accept borderline names. These figures indicate a much more efficient or economical use of the color descriptions for the color regions of sufficient interest to have received common names.

Turning to the most common pockets or definitions, at the other extreme, these are: moderate brown 28½ (26); vivid red 22 (21); grayish blue 21 (16); vivid reddish orange 20 (19); strong orange 17 (15); moderate blue 17 (14); grayish red 15 (15); moderate yellow-green 15 (14); light brown 15 (12); and light yellowish brown 14½ (14).

Turning to the hue names, blue is at the top with 85½ (69), red next with 83 (78), followed by brown 70 (61), yellow 66 (56), reddish orange 51 (45), and purple 50½ (43). Is this evidence for the oft-published favoritism for blue and red, and for Faber Birren's contention that only "simple" hues are preferred and remembered? At the other extreme, we have only 3½ (2) purplish pinks and 7 olive greens. There were 48½ (43) grays and "-ish" grays, including blacks and whites.

Turning finally to the saturation and lightness-darkness terms, there were no "very deeps" at all, only one "very light" and two "very light grayish" (both browns). At the other extreme were 222 (199) "moderate" which might be expected to be most numerous, 115 (100) "darker," 106½ (84) "light," 103 (88) "strong," 98 (84) "grayish," and 57½ (54) "vivid." Rather surprising is the small number of names described as "deep" 47½ (39), and still more so the number called "brilliant," 13½ (12).

It should be mentioned that M & P and TCCA, the main authorities for the color names, agree well. There are some cases where they agree in hue or in lightness (value), but not quite so well in the other two attributes, especially in chroma. But even where the Munsell notations differ somewhat, many corresponding M & P and TCCA colors fall in identical pockets. Among 165 pairs which could be compared, 40 fell in identical pockets and 23 more on the border, for one authority, of the

pocket filled by the other authority. Of the remaining pairs of colors, each pair of a given name, 46 pairs differed in only one attribute, 33 in two attributes and only 23 in all three. Even in some of the differing cases, the Munsell notations are close, but the colors fall on either side of the arbitrarily chosen borderlines. Examples are: Grecian rose, 7.5 R 6.1/4.8 (light grayish red) and 7.1 R 5.9/5.1 (dark yellowish pink); Yale blue, 6.5 PB 2.7/9.0 (deep blue) and 7.2 PB 2.9/9.1 (deep purplish blue). The most serious disagreements occur in such cases as Lilac. M & P's exemplar (light grayish red) was obtained by actual matches of lilacs under specified conditions, and was used by a French authority in 1905. TCCA's Lilac (moderate purple) is that very commonly used in the textile industry. If the general use of the color name was earlier than its employment in the textile field, as in the case of Old Rose (grayish red), then M & P's exemplar was considered the first standard, and in the Editor's list, the Old Rose "of TCCA" (dark pink) was considered the second or textile-color (TC) standard. But both were recognized and included in the above-quoted statistics. The reverse case, where TCCA was the earliest standard source was of course similarly treated. This simultaneous listing of different or similar definitions for colors of the same name is similar to ISCC practice in the ISCC Comparative List of Color Terms, serving to bring to a focus both likenesses and differences.

The general impression obtained by the Editor in reviewing the ISCC-NBS system, was that it has been notably successful in defining the colors in the way usual to and understandable by the average man or woman. Some color names containing "violet" are defined as purples, and conversely; but a little study shows that popular usage of these hue names is indefinite and arbitrary. The same is true to a lesser extent in the purplish red-red-orange-yellow region. The committee and the Bureau of Standards workers are to be heartily congratulated.

I. H. G.

MEASUREMENT OF DYE STRENGTHS

The May 29 number of the American Dyestuff Reporter contains an important report regarding "Measurements of Dye Strengths" by E. I. Stearns of Calco Chemical Division, American Cyanamid Company. Spectrophotometric curves are reported in interesting and useful fashion to relate curve differences as well as possible to visual differences - reflectance ordinates are spaced logarithmically, and the wavelength abscissa is spaced to accord with the photopic visibility function. The relation of strength locus to the Munsell concept of a visually uniform color space is diagrammed. The effect of shade differences in evaluating relative dye strengths is discussed. Pineo's equation is given for evaluating dye strength from spectrophotometric measurements and is discussed in relation to other suggestions that relate reflectance to concentration. Pineo took into consideration several factors relating to textiles not included in the Kubelka-Munk formulas; further, Pineo conceived the idea of making a cam and optical system for use on a spectrophotometer which cause it to plot his function directly (ref. U. S. Patents 2,194,910 and 2,218,357).

Dr. Stearns concludes that relative dye strength generally can be estimated visually to the nearest 5% and better by making two dyeings of each; blue dyes are more easily evaluated than yellow dyes; if two dyes differ in shade the strength comparisons will be approximate. The kind of fiber, method of dyeing, and concentration of dyeing are all factors that affect strength estimates.

COLOR OF PIGMENT MIXTURES

Through the Color Group of the Physical Society of Great Britain, a reprint has been received of what seems to be a

very basic discussion of the Colour of Pigment Mixtures, by D. R. Duncan of the Paint Research Station, Teddington, Middlesex, Jour. Oil & Colour Chemists' Assoc., 32, No. 349, 296-321, July 1949. A classification is presented of eight types of color mixtures. The laws governing color mixtures of pigments and pigmented compositions are explained and their application to practical problems discussed, with particular reference to the measurement of the relative values of the coefficients of scatter and absorption of different pigments and their use in predicting the color of pigment mixtures, the range obtainable from a given set of pigments, and the approximate proportions of different pigments which must be mixed to produce a given color.

Anyone dealing with color mixtures of any kind that now require use of a spectrophotometer should - if he has not already done so - make himself acquainted with the principles discussed in this paper. Several pages of discussion are included with the paper.

OTHER REPRINTS RECEIVED

From the Colour Group of the Physical Society: Shape Irregularities in the Equal Energy Luminosity Curve, L. C. Thomson (Visual Research Unit, Imperial College of Science and Technology), Proc. Phys. Soc. B, 52, 787-792, 1949. The photopic luminosity function of two observers with normal colour vision has been measured. Two shoulders on the curve in the blue region of the spectrum first noticed by Gibson and Tyndall have been confirmed, and the relationship of the curves to the standard C.I.E. luminosity function is discussed.

Visual Adaptation and the Apparent Saturation of Colours, R. W. G. Hunt (Research Labs., Kodak Ltd.), Letter to the Editor, Proc. Phys. Soc. B, 52, 203-206, 1949. A binocular colour-matching apparatus has been used to investigate the way in which the appearance of colored patches of light varies with the state of adaptation of the eye, using pre-exposures of I.C.I. illuminants A and B, and no stimulus.

On the Radiation from Transient Light Sources, F. Booth, Proc. Phys. Soc. A, 62, 95-113, 1949. (University of Bristol) A theoretical treatment is given of the problem of analyzing the radiation from transient light sources in the forms of clouds of incandescent particles. A critical examination is made of the Caldin method suggested for correlating this radiation with various physical parameters, and exact formulae are derived for special models.

From A.I.A. releases of papers on Light and Illumination at its recent meeting in Washington. The following four papers form an excellent series that we should like to have circulated to the entire ISCC membership.

Basic Factors of Vision, C. L. Crouch
The Visual Effect of Basic Light Distribution Patterns, Howard M. Sharp
Dramatic Uses of Light, Stanley McCandless
Daylighting, R. L. Biesele, Jr.

ANALYTICAL ABSORPTION SPECTROSCOPY

Analytical Absorption Spectroscopy (Absorptimetry and Colorimetry), edited by M. G. Mellon; John Wiley and Sons, New York; 618 pp. ; $9.00. This is a textbook written by nine specialists, each of whom wrote a chapter, including one by the editor, Professor M. G. Mellon of Purdue University, long well known as an exponent of the use of modern spectrophotometry and colorimetry in analytical chemistry. The reviewer's task is made difficult because he knows personally at

least five of the nine contributors, several being old friends. But it is easy to praise conscientiously, for he knows these men at least as the best available ones for their respective chapters, and it may be presumed that the others stand on the same high plane. To be sure, the editor, Prof Mellon, who wrote the chapter on Physics, is not primarily a physicist, but his discussion embraces only that part of physics in which he is thoroughly at home.

In a book written by several experts, the chief critical point a reviewer can assess is how well the work of the several contributors is coordinated. Suffice it to say that Prof. Mellon in the present case has done this well. There is some duplication, for example in the treatment of the Bouguer-Beer laws, discussed on pages 4, 18, 90-94, 122, 307,454 and 493; but the authors have put emphasis on different aspects or uses of the laws. A. C. Hardy's recent paper on the "failure" of Beer's law, which he calls rather a failure of the experimenter, is not mentioned. Filters are discussed on pages 19-20, 179-80 and 238-44, and filter photometers in Chapter 4. It is clear that the editor made a determined effort to avoid overlapping and inconsistent terminologies. An exception is Chapter 6, by E. R. Holiday, where a footnote states: "Since this chapter represents English usage in terminology, no attempt has been made to have the symbols and terms consistent with those of (National Bureau of Standards) Letter Circular LC-857, the standard adopted for the remainder of the book." In the preface we find also: "As editor I do not presume to have resolved the long-standing confusion between chemist and physicist on the usage of terms"; - and "colorimeter" is given as an example of this conflicting usage.

Chapter 1 (Chemistry) deals primarily in a logically developed manner with the preparation of systems for absorptiometric measurement. Here one of the weaknesses of the older "colorimetry" of the chemist is evident. Near the bottom of page 2 one finds: ".... a colorimetric method may be devised, provided the intensity of the coloration produced is essentially dependent upon the amount of desired constituent present and is stable ...." But "intensity" is nowhere defined; and unfortunately it has several meanings in colorimetry. Again, on page 49, lines 9-10, one is constrained to ask what is "maximum color." These questions will be raised again in connection with the last chapter. The end of Chapter 1 has a very useful table of methods. Though the editor decries "the artificial and overemphasized distinction between organic and inorganic chemistry," the table is divided into organic and inorganic halves. A very useful feature of the chapter is the long bibliography of 574 references.

The important Chapter 2, by Prof. Mellon, after an orienting introduction, deals with Terms and Symbols, Principles of Measurement, the Process of Absorption, Data and Conventions, Sensitivity, and Range and Accuracy. Under the first of these divisions, a very useful table of the comparative terms and symbols used by ten different texts is given. In the third division, the elementary mathematics of Bouguer's and Beer's laws is given, and the validity of the combined laws is discussed. Besides the "chemical" causes of deviation, the instrumental causes are discussed. In the section on plotting of data, six different methods are illustrated by five curves each.

The title, "Color Comparimeters," of Chapter 3, which the reviewer does not feel competent to discuss fully, shows him that he is a bit old-fashioned, for he would have called the instruments "comparators." Also, that he is perhaps too much a purist, for on each of the first two pages, he read with prejudice the term "intensity of the color." This term is used in more than one way, has not been defined

in the present sense, and perhaps as yet cannot be. Closely related concepts have been shown to be composite and involve complex psychophysical relations. The term is used on page 119 in connection with the relative luminosity curve, where the implication is that "intensity of color" depends on only one aspect (lightness-darkness) of the color perception. The reviewer believes that it depends also at least on the saturation, when two colors are compared. The discussion would be clearer if it were pointed out that, for given concentration changes, the resulting lightness change may in many cases be more perceptible than the saturation change. In another chapter, E. I. Stearns has discussed a similar problem. Chapter 3 contains some excellent examples of the isosbestic point, which is defined by Stearns.

The next two chapters, Filter Photometers and Spectrophotometers, were written by two masters. Professor R. H. Müller is an outstanding authority on instrumentation; and the review's chief reaction here is the wish that the author's chapter were longer. Subjects discussed include vacuum phototubes, barrier-layer cells, special circuits and servomechanisms. Dr. K. S. Gibson's contributions to, and writings on spectrophotometry, have marked him as an international authority in this field for at least 25 years, so that little needs to be said about his contribution. The treatment is similar to that in National Bureau of Standards Circular 484, Spectrophotometry, by Dr. Gibson, which was reviewed in the last News Letter. In each succeeding discussion of his field, he brings the treatment sharply up to date with new material. In his chapter, Dr. Gibson gives the essentials of the terminology of the Bureau's LC-857, which is followed in most of the book. In his introductory definition, he makes spectrophotometry relative, while spectroradiometry is absolute measurement, as these are performed in practice.

The reviewer does not feel competent to discuss the chapter on photographic methods. He will content himself with calling attention to the final summarizing statement by the author, E. R. Holiday, that "the photoelectric spectrophotometer is a more accurate and more convenient instrument than its photographic counterpart. For some special procedures photographic registration will continue to be superior." Chapter 8 on Infrared Spectrophotometers, is another which the reviewer does not feel fully competent to discuss. Reading as an amateur here, he may say that he finds the chapter logically developed, apparently as complete as may be expected in 76 pages, and well illustrated with figures and photographs of apparatus.

A long chapter by Dr. E. I. Stearns on Applications of Ultraviolet and Visual Spectrophotometric Data, alone would make the book a "must" buy for any colorimetrist in the dye and textile fields, or anyone regularly using a spectrophotometer. The chapter is replete with practical examples taken not only from the field just mentioned but also from biological materials and oils and fats. Here the elementary mathematics of additive absorbancies, and the addition and subtraction of transmittancy curves, is lucidly treated. Possibly some equations are made more formidable-looking than they are in fact by a complex notation which carefully reminds one which quantities are functions of wavelength, etc.; but that is a matter of personal preference. Under Solution Variables are considered various sources of error: effects of solvent, hydrogen-ion concentration, temperature, interfering ions, irradiation, component interaction, hydrolysis, light fading, fluorescence, turbidity, plating, etc. Methods are described and illustrated for qualitative and quantitative analysis by means of the spectrophotometer, and for the choice of wavelength in multi-component analysis. Applications of an "impurity index" are treated; curves illustrate the determination of purity of a dye and the course of purification, and identification by curve shape. Specific examples are taken from biological products, dyes and other sources. Possible duplication in the effects

of fluorescence here and in the Gibson chapter is kept to a minimum. There is a minor typographical error on page 369, where in equation 7.25 a subscript 2 is written in place of 1. The reviewer does not like the term "irradiation" for the reversible color change in light and darkness; for the dark process is as important as the light process and is not a radiation process; and also because the term emphasizes the cause, not the effect.

The last chapter, on Measurement and Specification of Color, is another written by the outstanding master of this subject, Dr. D. B. Judd. His treatment follows along lines familiar to most readers of the News Letter, and is similar to that of NBS Circular 478, described elsewhere in this issue along with other Bureau publications, except that Dr. Judd appears to have made more use of the concept of metamers than previously. The author has great facility in finding good examples to illustrate points of theory. On page 521 is a good example of matched oranges, spectrally unlike, which still match though greenish yellows under changed conditions. On page 560 is an excellent discussion of the difficulties of judging match on one-dimensional color scales. The difficulty of estimating nearest color match discussed on the next page is followed on page 562 by a quotation emphasizing such difficulties. They are related to those mentioned above by the reviewer in connection with the concepts of "intensity of color" and "maximum color." Judd's present treatment includes, among methods of computing tristimulus values, the Robinson semigraphical centroid method. It also devotes increased space to the Lovibond glasses and to the Union and Saybolt colorimeters. A long paragraph (pp. 588-9) on the Munsell renotations, a psychophysical specification, is worth very careful reading. The ISCC-NBS method of designating colors, discussed elsewhere in this issue, is described on pages 589-94. It should be pointed out that the system described is not the latest revision. At the top of page 590 Dr. Judd is too modest, as usual, when he says that the Bureau of Standards workers worked out merely the details of this method. The chapter ends with an excellent brief summary and a collection of thumbnail definitions of color terms.

One typographical error was mentioned above. Another occurs in Table 6.1 on page 276. In this fine table comparing stray light in prism and grating spectrographs, the ratio of 4.0 to zero (last two columns) is not zero, as given, but infinity. Near the top of page 133 is a statement similar to the often repeated one that "green is restful to the eyes." The reviewer has never been able to find evidence for this statement; indeed, what data exists points in the contrary direction. It would be more accurate to relate any eye fatigue to amount of light transmitted and to such factors as glare. The book as a whole bears the mark of the excellent Wiley typography and organization aids. It is one which must be on the bookshelves of every color worker and of those utilizing spectrophotometry and colorimetry for analytical purposes.

I.H.G.

BIRREN'S NEW BOOK — Faber Birren: Color Psychology; a Factual Study of the Influence of Color on Human Life; McGraw-Hill, New York; 1950; 284 pp.; $4.50.

It was once your reviewer's privilege to introduce Faber Birren as a speaker. He stated that he liked to read Birren's books, because he always enjoyed disagreeing with him; but that he had found less and less to disagree with in each succeeding book, and nothing so at all, with a minor exception to be mentioned, in Birren's last book. This was his "Selling with Color," which this reviewer still regards as Birren's best book. This is almost equivalent to saying that the new book is slightly anticlimactic. This reaction is not so much because of what is actually in the new book; it is more because of what was expected to be there! The

book's title names first "Color Psychology"; and Birren showed at least by 1941 in his "Story of Color" that he had thoroughly mastered much of the newer psychology of color and illumination, as developed by such men as Katz, Bühler, Gelb, Helson and Judd. The title led us to hope for more of Birren's exposition of this psychology.

The reviewer avoided reading the brief, lucid preface until he had finished the book. But early in the reading he concluded that the author's main thesis was this: Overly enthusiastic "chromopaths" have put "chromotherapy" in bad repute; much of value has in consequence been slighted, ignored, even reviled, but more sober and objective review should throw new light on an incipient science and aid in separating the wheat of fact from the chaff of fancy. And on page 28, we read "The chief purpose of this book is to present the story of color therapy as developed through research methods acknowledged and accepted by modern science." Birren states that he is not a research worker. But he is outstanding among color workers in the ability to put the findings of research to work in practice as well as to write lucidly about them. Moreover, as this reviewer implied at the start, his books, not excepting the present one, have shown a steady growth in his knowledge of the facts (and the fancies) of color. The preface states that two desires motivated the present work: (1) to assemble the wealth of factual data on color psychology and color therapy; and (2) to appeal to science and the medical profession to abandon old prejudices and "give color its honest due."

This field of color, says Birren, lends itself to "hyperbole and outright charlatanry," and its writers have put "rapture before reason." "If color is to cure human ills, physical or mental, greater proof of its efficacy will be required than mere exuberance." Whether the author succeeds in convincing the medical men, or even the color worker, will depend on how objectively he presents the facts and avoids the pitfalls of fancy. Everyone familiar with Birren's writing knows that color therapy is more than a hobby of his; it seems to be almost a major passion. It is asking too much to expect him to remain completely objective in the present argument. But a reading of the book shows that he has come reasonably close to doing so. On page 159 he sensibly admits that insulin shock and artificial fever are "far more potent" than colors for some purposes. On page 153 we find: "The strategy is perhaps not a matter of prescribing red over blue, or green over yellow at all, but of applying any color that will call forth a favorable reaction from the patient! ..... Color is beneficial when it appeals." This is to avoid the extreme of advocating specific therapeutic values for colors and to get closer to much present-day medical psychotherapy. And though he has much to say of Pancoast and Babbitt et al's writing, he appears to believe more in Dr. Felix Deutsch, who gathered evidence that changes in blood pressure, pulse frequency, rhythm and nervous tension are evoked by color associations.

But part of Birren's importance, and certainly of his charm, is that he does not lack the temerity to inject his educated intuitions into his consulting practice and his writings. The present work is no exception. No objective scientist would venture to prescribe an untried sequence of colors resulting from "sheer supposition," as Birren does on pages 262-3. His discussion of the associations of colors and foods (pp. 166-7), where empirical fact is tempered with intuitive feeling, is very good. But the reader is left in doubt whether the section is of factual data or theory.

On page 160 we find a tenet of the author's philosophy, that psychotherapy with hue also demands orderliness, harmony and beauty; and on page 256 it is stated that for red to be stimulating it must be pleasing. This goes beyond direct biological

effects and those connected with the mechanism of functioning of the eye as an organ; it introduces a "psychology of color," which (on p. 120) is defined as the emotional effects of color made evident in sensory reaction. At many points it is implied that biological effects of visible radiant energy may be expected because it is so similar to ultraviolet and infrared energy. On page 109-10, we find that red and blue light have great affective values, while green is "generally neutral." One wonders if this is because blue is close to ultraviolet, which is effective because of large quanta, and red similar to infrared and its heat effects, while green resembles neither.

It is hardly correct to say that cinnabar still continues to be used in the form of mercurochrome (misspelled, on p. 16). Wooley's inflated date for the ziggurat at Ur is used on page 9; and this is hardly one of the "oldest buildings of history," for buildings one or two thousand years older have been unearthed. A carpingly critical scientist, or even a never-carping one like Deane Judd, to whom the book is dedicated, might cite a number of other minor items which he would regard as not substantiated in fact. One is even led to suspect that Birren, in his weaker (or are they his stronger ?) moments, is on the side of "The Inspired Mystics" and others of his first five chapters whom the American Medical Association would bar from practice today. On page 12 he says: "Today modern scientific investigators are lending support to the astrologer's contentions...." Here the late Ellsworth Huntington's views are cited as almost paralleling the astrologers', thus verifying the latter's. But of him so sound and moderate critic as Professor Albright of Johns Hopkins, great archaeologist, historian and linquist, said in one book that Huntington was wrong "in all his deductions," elaborating the details of his wrongness in several pages of another book. Indeed, we wonder if Birren, good strategist that he is, did not make a tactical error in his first five chapters. Will not the medical men he wants to convince have their prejudices aroused and aggravated at the outset by 52 pages dealing with the Inspired Mystics, the Bewildered Philosophers, the Amulet Wearers, the Aural Healers and the Eager Chromopaths. And the medics may be too busy to read on.

But these chapters are undoubtedly interesting; and the remaining fifteen go on from the Historical to the Biological, Psychological and Visual Aspects. They lead up to chapters on Eyestrain, Functional Color and the Prescription of Color, where Birren is at his well-known best. No one can read this history of the use of color in medicine and therapy, real or fancied, without being conscious of the author's familiarity with a great wealth of color knowledge, of the impress of his personality and of the fact that Birren always has something worth saying in a field where he has done a lot of original thinking.

At the start, we said that we disagreed with only one thing in Birren's earlier book. This he called in the index Godlove's principle (in color harmony). We said, on the mentioned occasion, that we disagreed because it was later found not original with Godlove, and because Godlove no longer believed in it as a major principle. We are reminded of an incident in our college days. A "smart Alec" schoolmate protested that what the professor said contradicted our text book. "But," said the Prof, I wrote that book over five years ago. You've got to give me credit for some progress in five years." We are sure that in perhaps five years Birren's revision of his last book, under the present or a new title, will cite many more facts of color therapy, discovered because of the progress evoked by the stimulus due to the presently reviewed pioneer work.

I. H. G.

NOTE: An 8-page article in the May 17 issue of the Pathfinder magazine on color and Faber Birren has been widely used in various kinds of sales promotion color work. Many readers may have seen whole stores, and store windows, selling color through wide use of this Pathfinder cover. Through Francis Scofield of the Paint, Varnish, and Lacquer Association laboratories we inquired whether reprints of this article, which the association had reprinted with an NPVLA advertisement on the back cover, might be obtained for circulation to News Letter readers. Because their own reprint supply was exhausted, they inquired of the Pathfinder's Philadelphia office, through Mr. C. Haldane Johnson. Mr. Johnson was kind enough to supply the copies that are mailed to you with this News Letter. Any color-interested person will want to see this recent publicity on color; it is particularly appropriate to accompany an item which reviews Faber Birren's latest book.

D.N.

BIBLIOGRAPHY

E. Simonson & J. Brozek; J. Opt. Soc. Amer. 38, 384-97 (April 1948); Effects of illumination level on visual performance and fatigue

R. L. Sinsheimer, J. F. Scott & J. R. Loffbourow; Nature 164, 796-7 (1949); Use of thin films of sublimate for absorption spectroscopy

J. H. Skinkle et al; Amer. Dyestuff Rptr. 38, P 812-5, P 827 (1949); Quantitative (colorimetric) evaluation of dye characteristics and dyeing methods

D. Smith; Interchemical Rev. 7, 95-108 (1949); Evaluation of gloss

P. W. Smith; J. Soc. Dyers Col. 65, 743-7 (1949); Anomalous fastness of some dyed textiles

T. Smith; Proc. Phys. Soc. B62, 619-29 (Oct. 1949); Contributions of Thomas Young to geometrical optics, and their application to present-day questions

Y. Soejima; J. Sci. Research Inst. (Tokyo) 44, 36-40, 41-6, 63-7, 68-70, 71-3, (1949); Spectral transmission of thin films of metals; II, copper, III, cadmium, zinc and magnesium; IV, bismuth, antimony and arsenic; V, tellurium and selenium; VI, titanium and aluminum

E. Sondheimer & Z. I. Kertesz; J. Amer. Chem. Soc. 70, 3476-9 (1948); The (red) anthocyanin of strawberries

H. C. Staehle (to Eastman Kodak); U. S. Patent 2,472,128 (1949); Color designs on unglazed ceramics

W. S. Stiles; Ned. T. Natuurkde 15, 125-46 (June 1949) (in English) Determination of the spectral sensitivities of the retinal mechanisms by sensory methods

S. R. Stuart; Amer. Paint J. 33, No. 48, 24, 26, 29-30, 32 (1949); The future of color in the paint industry

R. S. Subrahmanya, K. S. G. Doss & B. Sanjwa Rao; Proc. Indian Acad. Sci. 27A, 411-20 (June 1948); Depolarization of light scattered by sols

T. W. Sukumlyn; U. S. Patent 2,472,991 (1949) Determining the wavelength of light with a quartz wedge

M. H. Sweet; J. Soc. Mot. Pict. Engin. 54, 35-62 (Jan. 1950) An improved photo multiplier-tube color densitometer

J. L. Switzer, R. C. Switzer & R. A. Ward; Br. Patent 599,490 (1948) Quinoline pigments

E. H. Symmons & J. Dixon; Photog. J. 89A, 291-3 (Dec. 1949) The background of colour photography in advertising

G. Szekeres; J. Opt. Soc. Amer. 38, 350-63 (April 1948); New determination of the Young-Helmholtz primaries

A. H. Taylor & W. G. Pracejus; Illum. Engin. 45, No. 8. 149-51 (1950); Fading of colored materials by light and radiant energy

Technicolor Motion Picture Corp.; Br. Pat. 607,792 (1948); Blue-green diazo dyes for color motion picture films

G. Toraldo di Francia; Proc. Phys. Soc. 62, 461-2 (July 1949); The radiation pattern of retinal receptors (directional sensitivity)

E. Vigroux; Compt. rend. acad. sci. 227, 272-4 (1948); Absorption of ozone in the visual spectrum

C. W. Voigt; Farben, Lacke, Anstrichstoffe 2, 70, 71 (1948): Chem. Abstr. 42, 7062 (1948); Yellow iron oxide

A. A. Vol'kenshtein & A. A. Gershun; Doklady Akad. Nauk S.S.S.R. 66, 59-61 (1949); Visual photometric measurements at low brightnesses

H. Wahl; 13, 77-84 (1948); Polymethine dyes (review)

R. Weale; Nature 164, 959-60 (Dec. 3, 1949); Absorption spectra, molecular weights and visual purple

H. Weil-Malherbe & J. Weiss; J. Che. Soc. 1948, 2164-9; Color reactions and adsorption of some aluminosilicates

W. A. Weyl; Amer. Ceram. Soc. Bull. 27, 59-61 (1948); Possible colors of the future (part of a symposium on color)

G. T. Winch; Engineering 167, 199-200 (1949); through J. Text. Inst. 40, A 272 (June 1949); Measurement of light and color

G. T. Winch; G. E. Co. J. 16, 197-203 (Oct. 1949); Colour and lighting (dependence on conditions)

Anon.; Home Movies 16, 213-4 (April 1949); How many colors are there? (colors distinguished by the General Aniline-Librascope Tristimulus Integrator)

Anon.; Nature 164, 176 (July 30, 1949); Photoelectric Spectrometry Group (Cambridge, Eng.)

Anon.; Phot. Soc. Amer. J. 15, 451 (Aug. 1949); New color meter (Ashcroft Standard Color Meter) indicates exact color temperature

E. Atherton & I. Seltzer; J. Soc. Dyers Col. 65, 629-38 (1949); Some studies of the fadingof simple monoazo dyes

H. Autrum, R. Tencher, H. Schaefer, A. Schraub, W. Friedrich & P. Jordan; FIAT Rev. German Sci. (1939-46); "Biophysics, II" (Off. Mil. Govt. Germany) 124-61 (1948) (in German); Biophysics of sense perception

J. E. Baer & M. Carmack; J. Amer. Chem. Soc. 71, 1215-18 (1949); Ultraviolet absorption spectra of aliphatic sulfides and polysulfides

R. B. Barnes & C. R. Stock; Anal. Chem. 21, 181-4 (Jan. 1949); Apparatus for transmission turbidimetry of slightly hazy materials

J. E. Bates & I. V. Runyan; J. Soc. Mot. Pict. Engin. 53, 3-24 (July 1949); Processing control procedures for Ansco color film

E. Baumgardt; Compt. rend. Acad. Sci. 228, 1795-7 (June 20, 1949); Visual acuity in fluorescent and incandescent light

N. S. Bayliss; Nature 163, 764-5 (1949); Spectra of iodine and bromine solutions

E. A. Becker; Farben, Lacke, Anstrichstoffe 3, 407-16 (1949); The pigment optics of white pigments

E. S. Becker; Electronics,(Nov. 1949), 90-91; Darkroom light meter

M. Bertolani; Atti. Soc. nat. e mat. Modona 77, 123-9 (1946); Chem. Abstr. 43, 6015 (Aug. 25, 1949); Red snow that fell in Jan. 1946, on Mt. Abetone (Italy)

F. J. Bingley; Proc. I.R.E.Sec. I 36, No. 6. 709-23 (1948); Color mixture: application of projective geometry

F. Birren: Sight-Saving Rev. 17, 217-27 (1947); Illumination and colour in industry

E. Boller, D. Brinkmann & E. J. Walter; "Introduction to the Study of Colour"; A. Francke, A. B. Bern (1947); pp. 147; Physics, physiology, psychology and esthetics of color

C. G. Bostrom & I. Kugelberg; Ophthalmologica (Basel) 114, 95-9 (1947); Official color tests in Sweden

P. J. Bouma; "Physical Aspects of Colour"; N. V. Philips Glocilampenfabricken, Eindhoven, The Netherlands (Elsevier Publ. Co., New York, distributors); 288 pp.; 1948; Brief review by R. M. Evans in J. Soc. Mot. Pict. Engin. 53, 103-4 (July 1949).

P. J. Bouma; "Physical Aspects of Color"; pp. 312, figs. 113; Elsevier Publ. Co.; New York, 1948; price $5.50; review by H. E. Ives in J. Opt. Soc. Amer. 39, 297 (April 1949)

E. J. Bowen; J. Soc. Dyers Col. 65, 613-7 (1949); Action of light on dyes

J. Bracey-Gibbon; Photog. J. 89A, 285-8 (Dec. 1949); Gevaert colour process

R. J. Braidwood; Prehistoric Men. Popular Series Anthropol. No. 37, 117 pp. p 50¢ 1948 Chicago Natural History Mus. Roosevelt Road & Lake Shore Drive, Chicago 5 (Formerly Field Mus. of Nat. Hist.)

J. Brozek, E. Simonson & A. Keyes; J. Appl. Psychol. 31, 519-32 (1947); Work test for quantitative study of visual performance and fatigue

P. Bruyalants, A. van Dormael & J. Nys; Bull. Acad. Roy. Belg. 34, 703-15 (1948); Relations between the planar structure of polymethine dyes and their absorption

E. P. Bundy & H. M. Strong; J. Opt. Soc. Amer. 39, 393-401 (May 1949); Transmission of light from diffuse sources by periscope tubes

R. W. Burnham; J. Opt. Soc. Amer. 39, 387-92 (May 1949); Comparison of color systems with respect to uniform visual spacing