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THE CONTRACTION OF THE COLOR ZONES IN HYSTERIA AND IN NEURASTHENIA.¹

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It is a well-known fact that certain nervous disorders may be attended by sensory disturbances. Diminished sensitivity to color is a prominent symptom; and the anæsthesia is usually described as a contraction of the retinal color zones. In acute stages of neurosis, these fields may contract to the vanishing point, leaving the retina wholly insensitive to color.

Investigators and practitioners have been interested in discovering what sequence is followed in this progressive contraction and ultimate disappearance of the color-zones. Besides being of diagnostic value, a knowledge of the progress of the disintegration of the color sense would probably enable one to read backward and obtain evidence on the phylogenesis of color perception.

The literature of the topic is scant and unsatisfactory. There is a vacillation and, in many instances, an utter disagreement among the discussions of the subject. And the details of experimentation are usually so vague as to preclude the possibility of reconciling the conflicting statements. One finds, on the whole, a consensus that the zones of red and of green are the first to disappear.² Yet many au-

¹ This number, dealing especially with pathology, has been prepared under the editorial care of Dr. Adolf Meyer.

² Thus Ch. Féré states that in epilepsy the green zone contracts most, red less and blue least of all. (Quoted by Otto Binswanger, in Nothnagel's *Specielle Pathologie u. Therapie*, 1904, XII., 1, S. 204.) Pichon, in 150 cases of epilepsy, also found a greater contraction for green than for red (*ibid.*). In atrophy of the optic nerve and in optic neuritis Jackson reports the same sequence of disappearance (Edward Jackson, *Diseases of the Eye*, Philadelphia, 1900, p. 392), while Ball gives red, green, blue, yellow as the order (*Modern Ophthalmology*,

thorities hold that pathological conditions of the nervous system are attended by a 'reversal' of the relative areas of the normal fields, and maintain that those zones which have the widest extension upon the normal retina are the first to disappear. This is tantamount to stating that the zones of blue and yellow disappear before those of red and green.¹ Must one infer that the gradual debilitation of the color-sense is characterized by a wholly irregular and non-uniform progression? Is it all a matter of individual idiosyncrasy of patient, or of type of disease causing the disintegration? Or shall one say that one is not yet in possession of the facts, and that the ground must be worked over again with more refined apparatus and methods?

It is a well-established fact that the zonal limits upon the normal retina are neither definite nor static. And indeed common sense would teach that the zone of any color tone is larger in proportion as the color stimulus employed in the exploration is brighter. Zonal area depends not upon color tone alone. The retinal limits within which the color of a stimulus may be perceived vary with variations in the brightness, in the saturation and in the area of the stimulus; they change with changes in the character of the background, in the conditions of retinal adaptation and of optic refraction. Every color zone of the normal retina may be narrowed down to the vanishing point, or may be extended to the outermost limits of the retina by an appropriate choice of conditions of exploration. It is obvious then that if one is to obtain *comparative* results, if one is to compare, *e. g.*, the relative areas of the zones of red and of green, one must take precautions to prevent either stimulus having an objective advantage over the other, as a physiological stimulus. In a word, one must choose color stimuli of equal brightness, saturation and area, and one must preserve uniform conditions of illumination (background), adaptation and refraction throughout the exploration. It seems probable that the

Philadelphia, 1904, p. 546). Sinkler (Wharton Sinkler in Loomis-Thompson's *System of Practical Medicine*, 1898, IV., p. 698) and Juler (H. E. Juler, *Handbook of Ophthalmic Science and Practice*, Philadelphia, 1904, p. 273) found the order of disappearance to be green, red, yellow, blue, in atrophy of the optic nerve and in hysteria. De Schweinitz (*Diseases of the Eye*, Philadelphia, 1903, p. 526) states that the usual sequence is green, red, blue, yellow, but cites exceptional cases in which red disappears first.

¹ Charcot, Parinaud and others state that in hysteria the red zone contracts most slowly and disappears last. And numerous authors have found that the field for red is even greater than that for white. Cf. Joseph Collins, in *Twentieth Century Practice of Medicine*, 1897, X., p. 464, and James M. Ball, *Modern Ophthalmology*, Philadelphia, 1904, p. 558.

confusion which one finds in the literature may be due to a failure to appreciate the significance of these coöperating factors.

The present paper is chiefly concerned with the exploration of the retinas of a number of hysterical and neurasthenic patients. Normal records, obtained under identical conditions of experimentation are introduced for comparison. The investigation was conducted in the Johns Hopkins Hospital. The writer is under obligation to Professor L. F. Barker, to Dr. C. P. Emerson and to Dr. B. A. Cohoe, of the hospital staff, for suggestions and for other aid. The explorations were made in diffuse daylight, and the apparatus employed was a camimeter with Hegg's sets of color discs.¹

These discs are furnished in three sizes — 6 mm., 13 mm. and 23 mm. in diameter. The accompanying tables contain records obtained with the largest and the smallest sizes. The background employed in the experiments was a strip of Hering gray paper 50 cm. wide and 3 m. long; upon this was marked a graduated scale for convenience in reading the determinations of zonal limits. At the center of the strip was pasted a disc of white paper, 5 mm. in diameter, which served as the fixation-point. An adjustable head-rest, secured at a distance of 1 m. from the fixation-point, completed the apparatus.

The observers were first tested as to normality of color vision by means of the Holmgren worsteds, and all were found to be normal. In the exploration experiments the color stimulus was brought in, along the background, toward the fixation point. Frequent pauses were made to prevent fatigue. The observer was always in ignorance of the color of the stimulus about to be employed. The point at which the color first appeared was taken to indicate the limit of the color zone. Three explorations were made with each color disc; the averages of the three readings, expressed in the nearest whole number, are set down in the following tables. The readings were reduced to degrees by a graphic method. The experiments were confined to the horizontal meridian — temporal and nasal, and both retinas were explored.

¹ Emil Hegg, *La périmétrie des couleurs*, *Annales d'Oculistique*, CIX., 1893, pp. 321 ff. *Sur la périmétrie au moyen de pigments colorés*, *Ann. d'Oc.*, CXI., 1894, pp. 122 ff. Hegg first established those colors which do not change in tone in indirect vision. Then he had a painter prepare mixtures of oil pigments which exactly reproduce the four stable tones in equal saturation and brightness. Hegg has put upon the market sets of discs, in three sizes, painted with the pigments described. The author is indebted to Mrs. C. Ladd Franklin, of the Johns Hopkins University, for the use of her sets of the Hegg discs.

The following tables show the horizontal extension of the zones which were sensitive to the stable colors, — purplish-red (*R*), bluish-green (*G*), blue (*B*) and yellow (*Y*).

TABLE I.
STIMULUS DISC, 23 MM. IN DIAMETER.

			Right Eye.		Left Eye.	
			Nasal Meridian.	Temporal Meridian.	Nasal Meridian.	Temporal Meridian.
			Degrees.	Degrees.	Degrees.	Degrees.
Patient 1.	HYSTERIA.	R.	28	20	27	23
		G.	27	21	26	23
		B.	42	26	42	29
		Y.	40	26	45	28
Patient 2.	NEURASTHENIA.	R.	22	13	23	14
		G.	24	14	24	15
		B.	33	24	35	22
		Y.	32	24	32	23
Patient 3.	NEURASTHENIA.	R.	31	19	27	20
		G.	30	18	27	19
		B.	41	25	36	26
		Y.	40	25	39	25
Patient 4.	NEURASTHENIA.	R.	26	20	29	22
		G.	28	19	28	21
		B.	36	27	38	30
		Y.	35	26	36	29
Patient 5.	NEURASTHENIA.	R.	25	19	28	20
		G.	26	20	28	20
		B.	33	26	35	26
		Y.	31	26	35	25
Patient 6.	NEURASTHENIA. (Sexual.)	R.	27	23	30	25
		G.	27	22	30	24
		B.	34	27	41	30
		Y.	35	27	39	30
Patient 7.	POST-TYPHOID PSYCHOSIS.	R.	12	10	21	14
		G.	11	11	20	13
		B.	24	18	30	20
		Y.	22	17	29	20
Observer A.	NORMAL.	R.	32	22	30	21
		G.	33	22	29	21
		B.	40	27	41	29
		Y.	40	28	39	30
Observer B.	NORMAL.	R.	29	20	30	22
		G.	30	21	31	22
		B.	39	29	40	31
		Y.	38	31	38	31
Observer C.	NORMAL.	R.	35	24	33	23
		G.	34	26	33	24
		B.	43	34	42	34
		Y.	42	34	40	36

TABLE II.

STIMULUS DISC, 6 MM. IN DIAMETER.

			Right Eye.		Left Eye.	
			Nasal Meridian.	Temporal Meridian.	Nasal Meridian.	Temporal Meridian.
			Degrees.	Degrees.	Degrees.	Degrees.
Patient 2.	NEURASTHENIA.	R.	*	10	*	10
		G.	*	10	*	12
		B.	23	19	24	18
		Y.	24	20	22	19
Patient 7.	POST-TYPHOID PSYCHOSIS.	R.	0	0	0	0
		G.	0	0	0	0
		B.	4	2	8	4
		Y.	6	4	8	6
Patient 8.	HYSTERIA. (Hysterical epilepsy.)	R.	8	6	9	7
		G.	8	6	8	7
		B.	*	10	*	10
		Y.	*	9	*	10
Observer A.	NORMAL.	R.	11	6	9	7
		G.	10	6	9	7
		B.	*	10	*	10
		Y.	*	9	*	10
Observer B.	NORMAL.	R.	10	9	11	9
		G.	10	10	10	10
		B.	*	17	*	17
		Y.	*	17	*	19

* Upon these meridians the outermost limit at which the color was recognized coincided with the edge of the blind-spot (about 12°). These readings are not tabulated for the reason that they represent an irregular and extraordinary condition of retinal sensitivity.

The most prominent features of these results are:

1. The color zones of the abnormal subjects examined are, on the whole, of smaller area than those of the normal subjects. This contraction is not common to all of the patients, *i. e.*, it is not an invariable symptom of the types of disorder represented by these patients. But it appears in the grand averages of all the results where one finds that the 'patients' zones have but 83 per cent. of the width of the 'observers' zones. And it is especially noticeable in the records of patients 2, 4, 5 and 7.

2. Wherever a contraction of the color zones has occurred it has followed a definite and regular order: (a) The narrowing of the red zone has gone hand in hand with that of the green zone, while that of the blue and that of the yellow zones have also kept pace with

each other.¹ (*b*) There is a greater degree of contraction in the red-green zone than in the blue-yellow zone. There is a slight indication of this in the grand averages, but it is particularly noticeable in the records of patients 1 and 7. Indeed when the exploration was made with discs of relatively slight stimulating power (Patient 7, Table II.), it was found that the color of the red and the green were no longer perceptible, while the blue and the yellow were still distinctly recognizable. Our results show the presence of a well marked tendency for the red-green zone to contract more rapidly than the blue-yellow zone; and in one instance there is a clear indication that the blue-yellow sense would continue to function after the red-green sense had wholly disappeared.²

¹ An apparent exception to this is to be found in the records of Patient 7, Table II., where the yellow was usually recognized farther out on the retina than the blue. This feature is unquestionably due to the influence of the macular pigmentation which absorbs blue light.

² This latter feature cannot be referred to the yellowish pigmentation of the macula. A series of experiments with stimuli of the same color tones showed that the normal fovea is more sensitive to the red than any other part of the retina. Nor can there be any doubt as to freedom from red-green blindness (see record of Patient 7, Table I.).