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AN INVESTIGATION OF CORRECTIVE TRAINING OF COLOR BLINDNESS

by

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Color Vision Report No. 15

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U.S. Naval Submarine Base, New London, Connecticut

Introduction

The training or coaching of color blinds to pass military color vision tests has for several years been of particular importance to the Navy. Unlike many other services, Naval service presupposes normal color vision in its personnel and consequently many Naval operations are coded on color. It is bad enough to have a color blind man in the Navy who knows he is color blind, but it is more dangerous to harbor color blind men who believe that their vision is now normal because they have been "cured".

The opportunities for coaching became widespread and reached dangerous proportions during World War II. Professional "treatments" were available in almost every town in America. A set of color blind "training" plates were published and sold to the public and placed in libraries for general reference. "Remedies" have been publicized on "science" programs over the radio and the radio scripts were distributed by the sponsors. It is now even possible to take a correspondence course in three easy lessons to enable one to pass whatever tests are used in a given service, with a money back guarantee. Most of the people who attempted color blindness training were sincere but uninformed in the physiological and psychological aspects of color vision, or believed they had stumbled upon something that would work. Others were probably happy to collect the \$25 to \$200 fees which were charged for a course.

Some of the methods which have been attempted are: repeated observation of bright colors; subcutaneous injection of iodine; electrical stimulation of the eyeball; warming of one eye; making of color judgments; observation of red and green lights; viewing dazzling lights through red, green and purple goggles; viewing flashing lights of various colors; dosage with extremely large quantities of vitamins, chiefly various preparations of vitamin A with stress on emulsification; the injection of cobra venom; repeated coaching on pseudo-isochromatic plates or other color blindness tests; continuous wearing of glasses tinted with the color of the presumed deficiency.

If any of these therapies were in any way useful, the selection sections of the Navy would be vitally interested, for many applicants must be rejected solely because of deficiency of color perception. A controversy has raged in newspapers and magazines and even in scientific journals for some years but without resolution. The cures became Hydra-headed. Since years of proper study are sometimes required to refute an improperly performed experiment, it appeared that there might be no end to the detailed argument. Therefore, it seemed desirable to gather the opinions of the foremost authorities on color vision in America. It will be found that the concensus of belief is

unanimous that no cure for congenital color blindness or mitigation of the deficiency has yet been discovered.

This report was assembled and submitted to committees of the American Medical Association by Lt. Comdr. Dean Farnsworth, head of the Color Vision Section of Medical Research Laboratory, upon their request and that of the Army-Navy OSRD Vision Committee. It has been accepted by the American Medical Association Section on Ophthalmology, the American Ophthalmological Society, the American Committee on Optics and Visual Physiology and the Association of Schools and Colleges of Optometry.

LETTER OF TRANSMITTAL:

U.S. Naval Medical Research Laboratory
U.S. Naval Submarine Base
New London, Connecticut
2 June 1947

Dr. Conrad Berens, Secretary
American Committee on Optics and Visual Physiology
of the Section on Ophthalmology, American Medical Assn.
American Ophthalmological Society
American Academy of Ophthalmology and Otolaryngology
301 East 14th Street, New York 3, N. Y.

Dear Dr. Berens:

In accordance with the request of the American Committee on Optics and Visual Physiology, acting on the inquiry of the Army-Navy NRC Vision Committee, which request you submitted to me, I herewith report on the conduct of an investigation on corrective training of color blindness.

The question of treatment of color deficiencies has been argued in the literature since 1873. If we were to continue to refight the old battle with each new hopeful writer, we would be forever retracing our steps and thereby retarded in projecting new, and more fruitful investigations. I have therefore thought it better to consult groups of the most prominent authorities and secure their unanimous opinions than to attempt further experiments or to encourage further argument concerning the pros and cons of the types of evidence already offered.

A significant aspect of the problem concerns publicity. There is something about color blindness that seizes the public imagination and attracts experimenters who are untrained in the amazingly complex field of color vision. It is hoped that the statements in the report will provide ammunition with which to hold these elements within reasonable bounds.

Sincerely yours,

Dean Farnsworth
Lt. Comdr., H(S) USNR
Head, Color Vision Section

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I

The views of the National Bureau of Standards, U. S. Dept. of Commerce, were requested on the subject of corrective training of color blindness. The following reply was proposed by Dr. Dean B. Judd, Physicist, as of 7 April 1947.

"It is our view that training on any given type of pseudo-isochromatic charts improves the ability to read the same charts markedly, but does not improve color perception at all. The increase in ability to read other pseudo-isochromatic charts of the same type does not in our opinion indicate an increase in color perception; it indicates an increased ability to take advantage of this training to viewing situations encountered in occupations on shore and at sea is to be expected.

"What actually happens when an individual having anomalous vision receives training of various kinds is progressive familiarization with the particular type of pseudo-isochromatic chart used to gage his progress. Possessing as he does a slight to vanishing perception of red-green differences, he has some sensory basis for reading the charts, but at least required long study to make out the numbers, and so fails. Repeated efforts to read the charts create the opportunity for practice and cut down the time required. The practice is more effective if the subject is informed of the correct response either verbally or by the use of selective filters to view the charts. Except for the Dvorine type of instruction, the periods of 'treatment' have no effect on the familiarization process, though they tend to create the delusion of an actual improvement in ability to distinguish red from green.

"These views are derived partly from our own experimental training of a few individuals with anomalous vision and partly from a study of the literature of the treatment of defects in color vision (about 30 papers since 1870). We deplore the practice of indiscriminate color-vision-test coaching, for that is what we believe the training amounts to; and regard it as a potentially dangerous practice. The following excerpts from a report which we issued in June 1943 to the Secretary of Commerce are worthy, we believe, of wide publicity:

"....Red-green deficiency, or reduced ability to discriminate any color from those of its neighbors that differ by being redder or greener, is fairly prevalent among healthy men, about 8 per cent having this defect from birth to an important degree. A red-green confuser may fail to notice the color of a red signal, or from a distance may be unable to

tell forest land from plowed land. He is therefore of secondary usefulness to the armed services.

"The Army and Navy use the so-called 'pseudo-isochromatic chart' form of test to detect red-green confusers. On such a chart colored dots form numbers easily read by a normal observer, but yield different numbers or no numbers at all to a red-green confuser. Failure to pass the pseudo-isochromatic test has barred hundreds of applicants from commissions or from entry into specialized branches of service. Many of these seek help to improve their vision and after two or three weeks 'treatment' reappear pass the test and are admitted. These occurrences have given rise to a belief that a man though red-green blind from birth can still develop a red-green sense from certain drugs, diets or other treatments; but more thorough tests indicate no significant improvement in ability to distinguish red from green. Instead they show that the pseudo-isochromatic charts, because of defects, probably unavoidable, can be read after several weeks' practice from clues other than red-green vision.

"The development of a test to supplement the convenient but not perfectly reliable pseudo-isochromatic charts is therefore an urgent need. The lives of the whole crew of a bomber or submarine may be the price to pay for the delusion of one crew member that his color vision is normal just because he took treatments and learned to pass a color vision test....."

II

The Inter-Society Color Council Subcommittee on Problem No. 11, Color Blindness Studies, was requested to formulate a statement for transmittal to the American Medical Assn. which would express the views of the members on corrective training of color blindness. The following statement was prepared by the Subcommittee, approved unanimously, and transmitted through the secretary, Dorothy Nickerson, by direction on 28 February 1947.

"Whereas it is generally agreed that in defective color vision confusion of certain colors currently used in signalling, coding, etc., is a common error; and also generally admitted that such confusion may endanger lives and property in peace or war; and whereas during the late war, certain practitioners, some unscrupulous, some well-intentioned by ignorance, under cover of 'corrective training by the color-blind' actually coached persons having defective color vision in the color vision tests used to qualify applicants for military service or for officers training, we wish to go on record as unconditionally condemning 'corrective training'.

"Reliable scientific evidence indicates that the majority of cases of marked deviation from normal color vision possess some congenital retinal or neural defect, which neither diet nor drugs, nor training in perceptual discrimination can remedy. No crucial role in passing the tests in current use is played either by facility in the use of color names, or by degree of familiarity with the various color tones - both stressed by the 'corrective' color trainers. Prolonged study of the color charts of the tests, however, enables the applicant to memorize digit series, familiarize himself with certain clues and tricks of composition, or utilize certain aids in viewing. Thus without materially improving his general color ability, he may pass the qualifying test on retrieval.

"In the interest, therefore, both of society, and of the individual, a false rating of whose abilities can in the end work only injury to his prospects, we condemn any training systems of the 'color-blind' which claim to be corrective.

"The above comment is not to be construed as discouraging research into the nature of defective color-vision. Nor does our censure apply to the possible alleviation or prevention of occasional acquired color deficiencies. Care should be exercised, however, in announcing minor success to the press, and thus raising false hopes."

III

The opinions of nearly every authority on color vision in America are represented in the above communications. They indicate that the best informed and most experienced specialists in the field of color vision are emphatically of the belief that congenital color deficiency cannot be remedied by the use of diet, medicine, training or other treatment now known to science.

IV

The major question has now been answered as a whole. An explanation of conflicting interpretations of experimental data may be found in the following statements which are selected with the idea of separating various phases of the problem more distinctly.

1. The basic psycho-physiological functions, as indicated by luminosity curves, color mixture ratios and other stimulus data by which normal or defective color vision is described, are unaffected by medicine, training, or other therapy.

2. Practice and coaching will undoubtedly enable a color deficient person to pass, or to show an improved score on, an imperfect test.
3. "But there is no well established proof that training a person to pass a color-blind test contributes to rehabilitation in the true sense of the word, because the skills developed have no practical value except that of defeating the purpose of the screening test.
4. "The only aspect of color-blindness that can probably be modified by training methods is the ability to differentiate chromas, and the tests used for measuring improvement should concentrate on this aspect of the problem.
5. "Improvement measured by such means could not be interpreted as a claim to have made changes in the other and more basic aspects of color-blindness.
6. "A program formulated on these principles would also be of value in training persons with normal color vision to achieve a finer discrimination of colors."

(Paragraphs 3, 4, 5, and 6 are in the words of Glenn A. Fry, Director, School of Optometry, Ohio State University, from "Rehabilitation of the Color Blind", Michigan Optometrist, November, 1943).

BIBLIOGRAPHY
Chronological Arrangement

- Favre, A., Reformation of railroad employees affected by Daltonism, Congr. de l'Assoc. franc. pour l'avancement des sciences (Lyon, 1873).
- Favre, A., Clinical studies on Daltonism and its treatment, Lyon med. No. 22 (1874).
- Favre, A., On the treatment of Daltonism in schools, (Lyon, 1877).
- Delboeuf, J. and Spring, W., Means of producing and of correcting Daltonism, Bull. de l'Acad. Roy de Belgique, 45, No. 1 (1878).
- Favre, A., On Daltonism, sanitary precautions and preventive means, Compt. Rend. 86, 1377 (1878).
- Javal, E., Correction of Daltonism, Gazette des Hospitales, No. 54, 430 (1878); also Progr. Med. No. 18, 340 (1878).
- Jeffries, J., Incurability of congenital color-blindness, Boston Med. and Surg. J., (March 28, 1878).
- Favre, A., The treatment of congenital Daltonism by exercise for children and for adults, Gazette hebdom. No. 6 and 7 (1879).
- Head, J. F., The Control of colour-blindness, New York Med. Rec. 17, 496 (1880).
- Jeffries, B. J., Color-names, color-blindness and the education of the color-sense in our schools, Education (March 1882).
- Kroll, W., On the successful results of training the color sense, Hirschberg's Centralbl. f. prakt. Augenheilkde, 6, 353 (December, 1882).
- Bianchi, Cure of color blindness, Gazette hebdomaire de Med. et de Chir., 92 (July 2, 1879).
- Burnett, S. M., Color perception and color blindness, Bull. of Phil. Soc. of Wash., 190 Meeting, (December 18, 1880).
- Cohn, H., Disappearance of color-blindness by warming one eye, Deutsche med. Wochenschr. No. 16 (1880); also Breslauer artztl. Zsf. No. 8 (1880); also Norstmann, Zentrbl. med. Wiss. 18, 536, (1880).
- Favre, A., Prognosis of Daltonism, Arch. d'Ophthal. 6, 229 (1886).
- Deneffe, On the perfectibility of the chromatic sense in the human species, (Bruxelles, 1888); also Annal. d'oculistique, 99, 249 (1888).

- Favre, A., Permanence of cure of congenital Daltonism treated by exercise, *Gazette hebdomadaire de médecine*. (2) 36, 598 (1888).
- Hegner, C. A., On unilateral congenital defects of the color sense, *Zsf. Sinnesphysiol.* 49, 18 (1916); also *Klin. Mhbl. Augenh.* 54, 81 (1915).
- Goldschmidt, R. H., Studies in practice therapy for strengthening the color sense of an anomalous trichromat. *Zsf. Sinnesphysiol.* 50 192 (1919).
- Roaf, H. E., A simple device whereby some color-blind persons can recognize color differences. *J. Physiol.* 59, 29 (1924).
- Meisling, Aage A., Color sense and color sense tests, *Acta Ophthalmol.* 3, 149 (1926); also *Am. J. Ophthalmol.* (3) 9, 558 (1926).
- Loken and Dunlap, Treatment of color-blindness with massive doses of vitamin A, *Psychol. Bull.* 39, 734 (1941).
- Dimmick, F. L., Vitamin A and color-blindness, *Inter-Society Color Council News Letter* No. 43, 3 (September 1942).
- Dunlap, K., and Loken, R. D., Anomalies of color vision, *Science*, 96, 248-249, 251-252, (1942).
- Wahlig, C. J., Physiological optics and color vision, *Bull. Optometrical Soc. (New York)*, 8, 7 (1942).
- Lepper, J. H., Reconditioning the color blind. *Optical Journal-Rev.*, February 1942.
- Swanson, W. L., Rehabilitation of the color blind, *Optometric Wkly*, 33, 864 (1942).
- Lepper, J. H., Case reports on reconditioning the color blind, *Optometric Weekly*, 33, No. 12, 314 (April, 1942).
- Shepard, C., Improving color vision, *Optometric Weekly*, 33, 1253, (1942).
- Lepper, J. H., Procedure for correcting red-green color blindness, *Optical J. Rev.*, 24 (October 15 1942).
- Elder, J. H., Effectiveness of vitamin A in the treatment of defective color vision intake, *Am. J. Pharmacy*, 115, 95 (1943).

- Legalley, D. P., and Harrison, J. W. E., Improvement of color vision by vitamin intake, *Am. J. Pharmacy*, 115, 95 (1943).
- Bridgman, C. S., Hoffstetter, H. W., "Improving" color vision, *Optometric Weekly*, 34, 471 (1943).
- Fry, G. A., Rehabilitation of the color blind, *Michigan Optometrist*, (November, 1943).
- Dvorine, I., New diagnostic method of testing and training color perception, *Am. J. Optometry and Arch. Am. Acad. Optom.*, 21, 225, (1944).
- Dvorine, I., Color perception charts, (The Waverly Press, Baltimore, 1944). (See previous reference).
- Dunlap, I., Defective color vision and its remedy, *J. Comp. Psychol.* 38, 69-85 (1945).
- Murray, E., Review of Dvorine's color perception charts, *Am. J. Psychol.*, 58, 276 (April 1945).
- Murray, E., Alleged cures of color blindness, *Am. J. Psychol.*, 58, 253 (April, 1945).
- Elder, J. H., Note on Dunlap's remedy for defective color vision, *Psychological Bull.*, 43, No. 1, 77 (January, 1946).
- Farnsworth, D., Review of Dvorine color perception testing and training charts, *Science*, 103, No. 2678, 545, (April 1946).
- Von Studnitz, G., Research on structure of retina, *Brit. Intel. Objectives Sub-Comm.*, Interrogation Report No. 70 (April 8, 1946).
- Dench, E. A., Color painting contrast in industry, *Optical J-Review*, (January, 1947).