DALTONIANA

NEWSLETTER
OF THE INTERNATIONAL RESEARCH GROUP ON COLOUR VISION DEFICIENCIES

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LITERATURE SURVEY

On threshold mechanisms for achromatic and chromatic vision, by M.A. BOUMAN and P.L. WALRAVEN (Dept. Medical and Physiological Physics, Utrecht, and Institute for Perception TNO, Soesterberg), Acta psychologica, 36, 178-189, 1972.

On the basis of measurements of the achromatic zone for red light in the fovea and for green licht in the periphery, a discussion is given on the possible difference in threshold mechanisms for the achromatic (scotopic) and chromatic (photopic) retinal systems. A specific suggestion for this distinction is given that not directly refers to the usual rod-cone concept but is based on the occurence of multiple coincidence of quantum absorptions by multiple hits per receptor no matter rod or cone as photopic signals, versus multiple coincidences by single hits per receptor in a distinct ommatodium type group of receptors as scotopic signals. - The Authors.

Color vision, by P.L. WALRAVEN (Institute for Perception, TNO, Soesterberg), Ann. Rev. Psychol., 23, 347-374, 1972.

For a long time color vision was a field for psychophysicists. Therefore theories of color vision were developed to explain certain aspects of color perception without taking into account "what is really going on" in the retina and the visual nervous system. What color vision theory must do, after all, is explain and describe how and what we see, in terms of what we call color. Objective studies of biochemistry and physical absorption of visual pigments, of the electrophysiological activity in the retina, lateral geniculate nucleus and higher centers do restrict the possibilities for a theory, but they leave much room for speculation. However, these objective data are not suitable as a basis for color vision theory without the reports of observers, often called subjective data. Both objective and subjective data must be explained. Altogether color vision is a fascinating topic for study. The tremendous amount of literature reflets this. Only

by strict selection and limitation could this review be kept within prescribed lengths. - The Author.

Parafoveal colour vision responses of four dichromats, by K.H. RUDDOCK, Vision Res. 11, 143, 1971.

The colorimetric performance of a tritanope, two protanopes, and a deuteranope was investigated both foveally and parafoveally. The contribution of rods to parafoveal color matches is discussed, and evaluated in terms of the individual observers. A two-stage model for color vision is proposed, being trichromatic in the first stage and opponent-process in the second stage, and the chromatic contribution of the rods in the parafovea is discussed within the context of this model. - Joel Pokorny.

Visual pigments in dichromats, by D.E. MITCHELL and W.A.H. RUSHTON, Vision Res. 11, 1033, 1971.

The methods of retinal densitometry and psychophysical brightness matching are used to investigate the photopigments of dichromats. The intensity required to produce a 50% bleach was established at a number of wavelengths by densitometry. That these various estimates of sensitivity are in fact equivalent to the sensitivities established in psychophysical situations was shown by having the observers match each of the bleaching lights to a yellow light of dominant wavelength 580 nm. Lights which produced equivalent bleaching were found to look equally bright to the dichromats. The conclusion was that the pigment measured by densitometry are the visual pigments. Psychophysical brightness matches were also made at a much lower intensity level. For protanopes, the curve at 200 tds closely coincided with that originally determined for the 50% bleach point (about 40,000 tds). For deuteranopes, the 200-td data closely matched the results of the densitometry, but the 40,000-td data are reported to show a shift of the whole curve towards blue. The 40,000-td data are not shown. - Joel Pokorny.

The red/green pigments of normal vision, D.E. MITCHELL and W.A.H. RUSHTON, Vision Res. 11, 1045, 1971.

This paper presents measurements on 7 normals, 11 protanomalous, and 5 deuteranomalous observers on an analytical anomaloscope. The analytical anomaloscope is a device which essentially allows changes in stimulation of only one of the pigments involved in the match, as the red/green proportion in the match is varied. This is accomplished in the following way : Let's say a protanope sets the red (dominant wavelength 637 nm) and the green (dominant wavelength 550 nm) to look equal, and equal to some intermediate wavelength. Then, variations in the ratio of red to green will all look equivalently bright and equal to the intermediate wavelength. If a normal observer looks at the instrument set in this way, called the "prot mode", he can make a match to the middle wavelength by simply varying the proportion of red to green.

His value assumes a unique point, in contrast to the protanope. This indicates that two pigments are active and if a match can be made, it indicates that the pigment that the protanope has is also present in the normal. Similarly, the instrument can be set in the deut mode and a similar logic applies. Results are presented for five intermediate wavelengths for normals in the prot and deut modes, and for protanomalous and deuteranomalous observers, with the protanomalous observers run in the prot mode, and the deuteranomalous observers run in the deut mode. The fact that such settings are possible for each of the anomalous classes indicates that the dichromat's pigment is present in each of these classes. - Joel Pokorny.

Les courbes spectrales photopiques d'efficacité lumineuse relative dans les déficiences congénitales de la vision des couleurs, by G. VERRIEST, Vision Res. 11, 1407, 1971.

Heterochromatic flicker photometry was used to evaluate the spectral sensitivity of 25 protanopes, 23 protanomals, 24 deuteranopes, 27 deuteranomals and 25 normal observers. Spectral sensitivity was determined by heterochromatic flicker photometry. The field size was 1.5°, surrounded by an adaptation field of 30° of equivalent luminance. Spectral sensitivity was determined at two levels of illumination : 55 and 415 tds. Differences between anomalous observers and dichromats of the same prefix were minimal. An analysis is performed of the intra-individual variability in each subgroup, and it should be noted that for the anomalous trichromats, there is no significant correlation between the anomaloscope data and the luminous efficiencies. In addition to the above-mentioned groups, seven typical achromats and one blue monocone monochromat were run. The achromats gave a spectral sensitivity concordant with the CIE scotopic luminosity function, with appropriate correction for absorption by the macular pigmentation. The blue cone monochromat gave a function peaking at about 450 nm. - Joel Pokorny.

Observations with Ishihara charts at low colour temperatures, low light intensity and limited exposure time, by H. KALMUS, Vision Res. 11, 1487, 1971.

Fifteen protan defectives and twenty deutan defectives diagnosed by anomaloscopy were asked to read Ishihara pseudoisochromatic charts under the following conditions : (1) with unlimited viewing time under daylight; (2) with unlimited viewing time and a tungsten source of color temperature of 3200° K ; (3) for five seconds under the tungsten source; and (4) for one second under the tungsten source. Kalmus states that the short exposure time with low color temperature illumination produces the best differentiation between protan and deutan defects. - Joel Pokorny.

A comparative study of several diagnostic tests of colour vision used for measuring types and degrees of congenital red-green defects, by J. HELVE, Acta ophthal., suppl. 115, Munksgaard, Copenhagen 1972.

The series was collected by examining conscripts in the North of Finland. The age of the subjects varied from 18 to 26 years. Only subjects with normal visual acuity and normal fundi were examined. Also myopic subjects were excluded from the material. The material consisted of 186 normal (including "minor colour defectives"), 55 protan and 132 deutan subjects. All were examined by using the Nagel anomaloscope (Neutralstimmung and Umstimmung), the 100-hue, the Panel D-15 and the pseudoisochromatic charts of Hardy, Rand and Rittler, Boström-Kugelberg and Boström. The light source in all pigment tests was a Macbeth Executive BBX 324 daylight illuminator.

The qualitative and quantitative results obtained by using the Nagel anomaloscope were compared to the results of the pigment tests. In general, the results obtained in pigment tests by subjects with extreme anomaly resemble the results obtained by subjects with dichromatism. The normal series included 14 subjects classified according to Pickford as "minor colour defectives". In the 100-hue test the results they obtained did not deviate consistently from those of the rest of the normal series. In subjects with anomalous trichromatism no correlation was found between the degree of deviation from the normal mid-matching point and the results of the pigment tests, whereas a good correlation was found between the matching range and the results of the pigment tests. In subjects with deutan defects bipolar concentration of errors was more pronounced than in protan types, the highest degree of bipolarity being found in subjects with deuteranopia and extreme deuteranomaly. The present results indicate that reliable information on the severity of the red-green defect can be obtained with simple and practical pigment tests. - The Author.

Some seeing problems : spectacles, color, driving and decline from age and poor lighting, by O.W. RICHARDS (Pacific Univ., College of Optometry, Forest Grove, Oregon), Amer. J. Optom. 49/7, 539-546, 1972.

Of interest to the readers of the Daltoniana is the chapter on "Color and Vision" of the Prentice Medal Lecture read by Richards before the Annual Meeting of the American Academy of Optometry, Toronto, Canada and representing a review mainly of his own research work. As a result of extensive field tests "Hunter orange", a daylight fluorescent orange having a dominant wavelength of 595-605 nm, a purity of 85% or greater and a luminance factor not less than 40%, was found to be the best color for protection of hunters. A table demonstrates that tinted contact lenses alter the Rayleigh equation on the Nagel anomaloscope appreciably. Unless the advantage of color contrast can be used. R. believes that only neutral glasses of the lightest of tints should be worn. When different absorbing lenses are worn on the patient's eyes at the same time or a colored lens is placed over only one eye a Pulfrich effect can ensue when the wearer is moving or judging speed and position of moving objects. When the dominant

wavelenghts of lenses worn at the same time are quite different chromatic aberration should be corrected by appropriate change in the powers of the Rx when clear vision is desired for seeing details in stereophotograms etc. - Ingeborg Schmidt.

Visibility of color contrast borders, by G.A. FRY (School of Optometry, Ohio State Univ., Columbus, Ohio) Amer. J. Optom. 49/5, 401-406, 1972.

The author demonstrates how in a bipartite field the dark line, which is due to an imperfect edge of a bi-prism used to split the field, can be avoided and how different variables can be controlled to produce an acceptable bipartite pattern for heterochromatic luminance matches and testing the sensitivity to differences in chromaticity. - Ingeborg Schmidt.

Color-blindness : deficiency disease, autoimmune or sex-linked inherited deficiency disease, by L.F. RAYMOND (North Caldwell, New Jersey), Eye, Ear, Nose Throat Monthly 51/4, 145-147, 1972.

2350 normal school children, age 7 to 17 years, were examined by the Ishihara plates. 10% of them showed color deficiency, males and females alike. Upon subsequent examination 8% of the red-green blind reverted to normal color vision spontaneously. The author assumes that a vitamin A deficiency type of color blindness must have been involved. A "typical case" is described, a 35 years old male, diagnosed as color blind by two previous examiners which restricted his flying activities. His mother was color blind and his father had normal color vision "contrary to our usually accepted theory". According to the HRR and the Ishihara plates the man had a red-green deficiency. Intradermal tests for bacterial endotoxins and airborne pollens showed positive findings. Diluted antigenic solutions of the aforementioned were administered which corrected the color deficiency so that the color vision restriction was removed from his flying certificate. Repeat examinations one and two years later showed color vision to be normal. The effect of the antigenic therapy permits to assume an allergic nature of the process causing the color deficiency. The author claims to have treated a total of 21 cases of this type successfully. - Indeed, a peculiar paper! The reported facts and the theoretization seems to be more than problematical. - Ingeborg Schmidt.

LISTS OF THE PUBLICATIONS ON COLOUR VISION
DEFICIENCIES OF MEMBERS OF THE RESEARCH GROUP

22. Papers by Dr. Marion MARRE (Augenklinik der Medizinische Akademie, Fetscherstrasse 84, 8019 DRESDEN, D.D.R.).

R MARRE M. and GRAEBER A. - Farbtüchtigkeit und Beruf, Tagungsber. int. Farbentagung Interfarbe 68, Dresden.

R MARRE M. - Die Darstellung von 3 Farbsehmechanismen bei erworbenen Farbensehstörungen, Tagungsber. AIC "Color 69" Stockholm 1, 97-106, 1969.

MARRE M. - Eine quantitative Analyse erworbener Farbensehstörungen, Habilitationsschrift, Magdeburg, 1969.

MARRE M. - Erworbene Farbensehstörungen, Kongressbericht 7. Kongress der Gesellschaft der Augenärzte der DDR 7. - 9.5.1970, Magdeburg.

R MARRE M. - Clinical examination of three color vision mechanisms in acquired color vision defects, Mod. Probl. Ophthal. 11, 224-227, 1972.

23. - Papers by Miss Helen M. PAULSON (Naval Submarine Medical Research Laboratory, Naval Submarine Base, New London Box 600, GROTON, Connecticut 06340, U.S.A.).

R PAULSON, Helen M. - The performance of the Farnsworth lantern. at the Submarine Medical Research Laboratory and in the Field from 1955 to 1965. Naval Submarine Medical Center, Groton, Conn., SMRL Rep. No. 466, Jan. 1966.

R PAULSON, Helen M. "Color Vision Testing in the United States Navy", in Visual Science (John R. Pierce and John R. Saveane, Editors), Indiana University Press, Bloomington and London, 1971, pp. 164-176.

R PAULSON, Helen M. - Comparison of Color Vision Tests Used by the Military Services. Naval Submarine Medical Center, Groton, Conn., SMRL Rep. No. 685, Oct. 1971. (This paper was presented at Annual Meeting of the Armed Forces National Research Council Committee on Vision in May 1971 and will appear in the Proceedings of this Meeting also).

Also, paper given by Paulson at Symposium on Visual Perception in Williamsburg, Virginia, February, 1969, entitled, "Detecting and Classifying Color Defectiveness." This paper has not been published.

24. - Papers by Prof. R.W. PICKFORD (Psychology Dept., Adam Smith Building, The University, GLASGOW W 2, Scotland).

PICKFORD R.W. - Women with Colour Blind Relatives, Nature, 153, 409, 1944.

PICKFORD R.W. - Darkened Violet in Colour Vision, Nature, 156, 506, 1945.

PICKFORD R.W. - Factorial Analysis of Colour Vision, Nature, 157, 700, 1946.

PICKFORD R.W. - Sex Differences in Colour Vision, Nature, 159, 606, 1947.

PICKFORD R.W. - Frequencies of Sex-Linked Red-Green Colour Vision Defects, Nature, 160, 335, 1947.

PICKFORD R.W. - Darkening of Red in Protanopia, Nature, 161, 27, 1948.

PICKFORD R.W. - Race, Pigmentation and Colour Vision, Nature, 161, 1687, 1948; Advancement of Science, 6, 21, 76, 1948.

PICKFORD R.W. - Colour Blindness in Left Eye Following an Accident, Brit. J. Psychol., 39, 73-83, 1948; Nature 156, 336, 1945.

PICKFORD R.W. - Human Colour Vision and Granit's Theory, Nature, 162, 414, 1948.

PICKFORD R.W. - Multiple Allelomorphs in Colour Vision, Nature, 162, 684, 1948.

PICKFORD R.W. - Individual Differences in Colour Vision and their Measurement, J. Psychol., 27, 153-202, 1949.

PICKFORD R.W. - Colour Vision of Heterozygotes for Major Red-Green Defects, Nature, 163, 804, 1949.

PICKFORD R.W. - Brightness and Saturation of Colours for Red-Green Defectives, Nature, 164, 236, 1949.

PICKFORD R.W. - A Study of the Ishihara Test for Colour Blindness, Brit. J. Psychol., 40, 72-80, 1949; Nature, 153, 656, 1944.

PICKFORD R.W. - Three Pedigrees for Colour Blindness, Nature, 165, 82, 1950.

PICKFORD R.W. - An Item-Analysis of the Ishihara Test, Brit. J. Psychol., 41, 52-62, 1950.

PICKFORD R.W. - Red Anomaly Dominant to Protanopia, Nature, 165, 980, 1950.

PICKFORD R.W. - Motokawa's Data and the Four Colour Theory, B.P.S. Quart. Bull. 2, 12, 61, 1950.

PICKFORD R.W. - Evidence Favouring a Four-Colour Theory, Proc. 12th Int. Congress of Psychology, 1948 p. 103, 1950.

PICKFORD R.W. - Colour Vision of an Albino, Nature, 168, 954, 1951.

PICKFORD R.W. - The Genetics of Colour Vision , Proc. 13th Int. Congress of Psychology, 199-200, 1951.

PICKFORD R.W. - Individual Differences in Colour Vision, Routledge and Kegan Paul Ltd, 1951.

PICKFORD R.W. - A Pedigree for Green Anomaly, Nature, 169, 503, 1952.

PICKFORD R.W. - Further Work on Individual Diifferences in Colour Vision, B.P.S. Quart. Bull., 3, 15, 17-19, 1952.

PICKFORD R.W. - Inheritance of Minor Colour Vision Variations, Nature, 171, 1167, 1953.

PICKFORD R.W. - A Pedigree for Three Types of Colour Vision Defect, Nature, 172, 1010, 1953.

PICKFORD R.W. - Some Problems of Anomalous Colour Vision, Brit. J. Psychol., 45, 115-128, 1954.

PICKFORD R.W. - Weak and Anomalous Colour Vision in Industry and the Need for Adequate Tests, Occupational Psychology, 29 182-192, 1955.

PICKFORD R.W. - Colour Blindness and its Inheritance, Biol. and Human Affairs, 21, 19-26, 1956.

PICKFORD R.W. - Dominance Order for Red-Green Defective Alleles, Nature, 178, 49-50, 1956.

PICKFORD R.W. - A Practical Anomaloscope for Testing Colour Vision and Colour Blindness. Brit. J. Physiol. Optics, 14, 2-26, 1957.

PICKFORD R.W. - The Testing Measurement Inheritance and Theory of Colour Vision, The Scottish Optician, June 1957, 8-10.

PICKFORD R.W. - The Colour Vision of Achromat's Parents, Nature, 180, 926-927, 1957.

PICKFORD R.W. - Colour Vision of Three Albinos, Nature, 181, 361-362, 1958.

PICKFORD R.W. - A Review of Some Problems of Colour Vision and Colour Blindness, Advancement of Science, 25, 58, 104-117, 1958.

PICKFORD R.W. - Some Heterozygotes Manifestations of Colour Blindness, Brit. J. Physiol. Optics, 16, 83-95, 1959.

PICKFORD R.W. and KHERUMIAN R. - Hérédité et Fréquence des Anomalies Congénitales du Sens Chromatique (Dyschromatopsies). Vigot Frères, Paris, 1959.

PICKFORD R.W. - The Inheritance and Frequency of Colour Blindness. Surge : Glasgow University Medical Journal, 26, 29-32, 1959.

PICKFORD R.W. and LAKOWSKI R. - The Pickford-Nicolson Anomaloscope for Testing and Measuring Colour Vision and Colour Blindness, and other Experiments and Tests, Brit. J. Physiol. Optics, 17, 131-150, 1960.

PICKFORD R.W. - Variations Mineures de la Vision des Couleurs, "Couleurs" (Paris), 36, 27-28, 1960.

PICKFORD R.W. - Colour Vision and Its Measurement, Recent Trends in Psychology, 92-103, 1961.

PICKFORD R.W. - Compound for Red-Green Colour Vision Defects, Vision Research, 2, 245-252, 1962.

PICKFORD R.W. - A Brief Review of Some Factorial Studies of Colour Vision, Die Farbe, (Berlin), 11, 1/6, 59-68, 1962.

PICKFORD R.W. - Natural Selection and Colour Blindness, The Eugenics Review, 55, 2, 97-101, 1963.

PICKFORD R.W. - The Genetics of Colour Blindness, Brit. J. Physiol. Optics, 21, No. 1, 39-47, 1964.

PICKFORD R.W. - Some Scientific Problems of Differences in Colour Vision, Biology and Human Affairs, Vol. 29, No. 3, 23-29, 1964.

PICKFORD R.W. - Natural Selection and Colour Blindness, Actes des VIIèmes Journées Internationales de la Couleur, Padua, 2-7 Mai 1963, 296-305.

PICKFORD R.W. - A Deuteranomalous Artist, Brit. J. Psychol., 55, 460-467, 1964.

PICKFORD R.W. - Art and the Unconscious, Davidson Clinic Bulletin (Edinburgh). No. 73, 1964.

PICKFORD R.W. - Influence of Colour Vision Defects on Painting, Brit. J. of Aesthetics, July 1965, Vol. 5, 211-226, 1965.

PICKFORD R.W. - Two Artists with Protan Colour Vision Defects, Brit. J. Psychol., 56, 421-430, 1965.

PICKFORD R.W.- The Genetics of Colour Blindness, Colour Vision: Physiology and Experimentel Psychology. CIBA Foundation, Ed. A.V.S. de Reuck and Julie Knight, London, 238-248, 1965.

PICKFORD R.W. - Colour Vision, Colour Blindness and Anomaloscope Tests, Psychology Today, University of Newcastle-upon-Tyne, Psychology Department, 1-20, 1965.

PICKFORD R.W. - Colour, Colour Vision and Colour Blindness, Journal of the Colour Group, Vol. 8, Oct. 1966, 73-75, 1966.

PICKFORD R.W. - Three Artists with Defective colour Vision, Die Farbe : Int. Farbtagung (Luzern 1965), pp. 254-260, 1966.

PICKFORD R.W. - Colour Defective Students in Colleges of Art, Brit. J. Aesthetics, 7, 132-136, 1967.

PICKFORD R.W. - Liebreich's Sign of Colour Blindness in Artists, Proc. XVIII Internat. Congress Psychol. (Moscow), Abstracts, Vol. II, 222-223, 1967.

PICKFORD R.W. - Variability and Consistency in the manifestation of Red-Green Colour Vision Defects, Vision Research, 7, 65-77, 1967.

PICKFORD R.W. - Colour Blindness : Anomaloscope Tests and Physiological Problems, International Journal of Neurology, 6, 210-221, 1968.

PICKFORD R.W. and TAYLOR W.O.G. - Colour Vision of Two Albinos, Brit. J. Ophthal., 52, 640-641, 1968.

PICKFORD R.W. - A Pedigree showing variability in Deuteranomaly, Vision Research, 8, 469-474 and 719 and 1172, 1969.

PICKFORD R.W. - Colour Vision Research in Scotland in the First Part of the 20th Century. Contemporary Research in Psychology of Perception : In Honorem Kai von Fieandts Sexagenar ii.. W.S.O.Y. Finland, 127-139, 1969.

PICKFORD R.W. - The Colour Defective Art Students, Proc. and Internat. Congress for Empirical Aesthetics, Bologna, pp. 179-193, 1967 (in Italian).

PICKFORD R.W. - Review Article : The Lüscher Colour Test, Occupational Psychol., 45, 151-154, 1971.

PICKFORD R.W. - A Case of Hysterical Colour Blindness Reconsidered, Mod. Probl. Ophthal., 11, 130-132, 1972.

PICKFORD R.W. - Weak and Anomalous Colour Vision in Industry and the Need for Adequate Tests (to be published).

PICKFORD R.W. - Alternative Appearances of Pictures for Normal and Colour Vision Defective Viewers, Sciences de l'Art. (in press).

R 25. - Papers of Dr. Joel POKORNY and Dr. Vivianne C. SMITH (Eye Research Laboratory, 950 E. 59th St., Chicago Ill. 60637, U.S.A.).

R SMITH C.V. and POKORNY J. - Anomaloscopic settings with added chromatic fields : the use of red light to reproduce protan function. Invest. Ophthal. 9,: 543-550, 1970.

R POKORNY J., SMITH V.C. and SWARTLING R. - Threshold measurements of spectral sensitivity in a blue monocone monochromat, Invest. Ophthal. 9, 807-813, 1970.

R POKORNY J. and SMITH V.C.,- Luminosity and CFF in deuteranopes and protanopes. J. Opt. Soc. Amer. 62, 111-117, 1972.

R SMITH V.C. and POKORNY J. - Spectral sensitivity of color-blind observers and the cone photopigments. Vision Res. 12, 2059-2071, 1972.

PERSONALIA

Leo M. Hurvich and Dorothea Jameson were presented the Distinguished Scientific Contribution Award by the American Psychological Association at its meeting held in September 1972 in Honolulu, Hawaii.

OFFICIAL COLOUR VISION REQUIREMENTS

DENMARK (1972)

	Colour vision requirements
Private car :	Licensing : no restrictions.
Lorries, taxis, busses :	no restrictions.
Railways :	personnel dependent on coloured signals : normal.
Tramways :	no restrictions.
Aviation :	private license : normal. Waivers, however, granted for others than dichromats and extreme anomalous trichromats provided radio equipement can be operated during flight.
Aviation :	private license, instrument rating : normal.
Aviation :	commercial pilots, air traffic centrollers : normal.
Aviation :	Flight engineers, Navigators: : deuteranomalous and protanomalous pass, extreme anomalous trichromates and dichromats rejected.
Aviation :	military : normal.
Merchant shipping and Navy :	Deck personnel : normal.
Navy personnel :	in special service same requirements as flight engineers.
Army :	no restrictions.

The Ishihara plates or Boström-Kugelbergs and Boström II, in combination, are authorized as screening instruments.

Colour normals are defined as subjects who make no errors in these plates. Doubtful cases are evaluated according to the results of a Nagel anomaloscopic examination. No colour lantern is officially authorized.

V. Dreyer.

SWEDEN (1972)

	Colour vision requirements	Tests
Road traffic		
private car, lorry taxi	no limitations	
bus	normal colour vision *)	Boström II B and Boström-Kugelberg B.-K. In doubtful cases also anomaloscope
Railway		
employees in "security service" (e.g. engine-drivers, pointsmen)	normal colour vision	as above
Aviation		
military	normal colour vision or protanomaly/deuteranomaly without increased exhaustion and with only insignificantly increased contrast	as above
civil		
Cat. I and II (profess.)	as military above with the addition of sharp matching range	as above
Cat. III and private air pilots and gliders	as above or no limitations if limited to flight during daytime and when no colour signals are used	as above
Marine		
Civil (officers, steermen and lookoutmen)	normal colour vision	as above
military (deck)	normal colour vision	as above

*) will probably be altered to "no limitations" in the near future

A. Hedin

NORWAY (1972)

	Colour vision requirements	Tests
Private car driving :	No limitations	
Lorries, taxis, busses :	No limitations	
Railways :	Normal colour vision required for all security personnel	Ishihara, Boström Kugelberg or other approved tests. Anomaloscope in doubtful results.
Tramways, subways :	As for railways	As for railways
Aviation, professional :	Normal	Ishihara and B-K. If doubtful : Anomaloscope and colour lantern (Schiøtz).
Aviation, private :	Normal Dispensation granted (with some limitations) for moderately colour defectives.	The same
Mercantile marine :	Normal colour vision required for "helm and look-out-service" (personnel on deck).	2 tests compulsory out of 3 approved tests : Ishihara, B-K and/or Kugel-Stilling. (Certificate for colour vision being issued only by doctor who have proved normal colour vision themselves). If doubtful : Anomaloscope.
Navy	Normal colour vision required for all officers and for personnel on deck.	No special tests compulsory, but Ishihara most commonly used.
Army	No limitations except for special duties (munition depots and telegraphy).	the same
Aviation army :	Normal colour vision required for all security personnel	As for aviation, professional.

Egill Hansen.