DALTONIANA

NEWSLETTER
OF THE INTERNATIONAL RESEARCH GROUP ON COLOUR VISION DEFICIENCIES

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LITERATURE SURVEY

Cerebrale Achromatopsie (Symptomatik, Verlauf, Differentialdiagnose und Strategie der Untersuchung) by W. Jaeger, H. Krastel and S. Braun, (Univ.-Augenklinik, Im Neuenheimer Feld 400, 6900 Heidelberg, FRG) Cerebral Achromatopsia - signs and symptoms, course, differential diagnosis, examination strategy. Parts I and II. Klin. Mbl. Augenheilk, 193, 627-634, 1988 and 194, 31-36, 1989.

To the patient, the sudden onset of cerebral achromatopsia is like switching to black and white on a colour TV. As a rule, the defect arises due to bilateral ischemic infarction in the inferior occipitotemporal region. Bilateral upper homonymous quadrantanopsias usually leave the macula more or less unimpaired, so that visual acuity is largely preserved. Prosopagnosia and loss of topographic memory are often associated with central achromatopsia. Investigations of color vision must include color-naming procedures and large field tests in addition to the conventional methods. Color-naming tasks are indispensable in differentiating cerebral achromatopsia from the aphasic and disconnective types of color anomia. The authors' recommended strategy for investigating color vision relies on records of a case of cerebral achromatopsia obtained six months and two years, respectively, after the onset of

symptoms. In addition to the above-mentioned procedures, spectral increment thresholds on white and colored backgrounds were determined. For the first time in cerebral achromatopsia, examinations with large-field spectral matches were performed using the projection anomaloscope. Large-field tests are indispensable for monitoring recovery in cases of central achromatopsia. In the author's patient, recovery of blue-green discrimination was far more complete than that of red-yellow-green discrimination, and for both conditions large-field color vision was far superior to small-field. - The Authors.

Hue signals from short- and middle-wavelength-sensitive cones by B. Drum (Wilmer Eye Institute, Johns Hopkins Hospital, 601 N Broadway, Baltimore, MD 21205, USA). J. Opt. Soc. Am. A. 6, 153-157, 1989.

Hue sensations resulting from the selective stimulation of short-wavelength-sensitive (S) and middle-wavelength-sensitive (M) cones were deduced from measurements of spectral unique green and unique blue under conditions of high or low S-cone sensitivity relative to M- and long-wavelength-sensitive cone sensitivity. Selective reduction of S-cone stimulation shifted unique blue toward shorter wavelengths and unique green toward longer wavelengths, implying losses of perceived yellowness and short-wavelength redness relative to perceived blueness. The results imply that, under achromatic adaptation conditions, M-cone stimulation yields a sensation of predominantly bluish cyan and S-cone stimulation yields a sensation of predominantly reddish magenta. S-cone stimulation also appears to be indirectly responsible for yellowish sensations at long wavelengths and, by cancellation of the M-cone blueness signal, for greenish sensations at middle wavelengths. Substantial revisions of current models of color vision are needed to account for these results. - The Author.

"Tho' she kneel'd in that place where they grew ..." The uses and origins of primate colour vision, by J.D. Mollon (Department of Experimental Psychology, University of Cambridge, Downing Street, Cambridge, CB2 3EB), J. exp. Biol. 146, 21-38, 1989.

The disabilities experienced by colour-blind people show us the biological advantages of colour vision in detecting targets, in segregating the visual field and in identifying particular objects or states. Human dichromats have especial difficulty in detecting coloured fruit against dappled foliage that varies randomly in luminosity; it is suggested that yellow and orange tropical fruits have co-evolved with the trichromatic colour vision of Old World monkeys. It is argued that the colour vision of man and of the Old World monkeys depends on two subsystems that remain parallel and independent at early stages of the visual pathway. The primordial subsystem, which is shared with most mammals, depends on a comparison of the rates of quantum catch in the short- and middle-wave cones; this system exists almost exclusively for colour vision, although the chromatic signals carry with them a local sign that allows them to sustain several of the functions of spatiochromatic vision. The second subsystem arose from the phylogenetically recent duplication of a gene on the X-chromosome, and depends on a comparison of the rates of quantum catch in the long- and middle-wave receptors. At the early stages of the visual pathway, this chromatic information is carried by a channel that is also sensitive to spatial contrast. The New World monkeys have taken a different route to trichromacy: in species that are basically dichromatic, heterozygous females gain trichromacy as a result of X-chromosome inactivation, which ensures that different photopigments are expressed in two subsets of retinal photoreceptor. - The Author.

A computer-controlled colour vision test that combines the principles of Chibret and of Stilling, by J.D. Mollon and J.P. Reffin (Department of Experimental Psychology, Downing Street, Cambridge, CB2 3EB), J. Physiol., 414, 5P, 1989.

Computer-controlled displays have been used successfully for testing congenital and acquired deficiencies of colour vision (Eg, Vingrys & King-Smith, 1986; Arden et al. 1988): typically the subject is required to detect a spot or a grating on a raster screen, and the chromaticity of the target is modulated along varying axes of colour space (as in the chromatophotometer of Chibret, 1887). But two factors may restrict such displays to the laboratory and prevent their use for general screening: (a) if minor misalignments of guns occur, the targets may reveal themselves by edge artifacts (Vingrys & King-Smith, 1986), and (b) if the experimenter is to be confident that only chromatic pathways are being probed, luminosity equations must be made for each individual patient. Closely analogous problems faced the designers of the first pseudoisochromatic plates. The stratagems adopted by Stilling (1883) were (a) to form the stimulus array from discrete patches each with its own contour, and (b) to vary randomly the reflectances of the patches.

The present test employs an array of discs of varying size and luminance. A subset of discs differ in chromaticity from the background and form a Landolt C. The subject is asked to press one of four buttons corresponding to possible orientations of the target. Excursions of chromaticity are made along protan, deutan and tritan confusion lines in colour space; and the magnitude of the excursion is adaptively adjusted according to the subject's performance. The test reliably separates protan and deutan types of congenital deficiency and gives a quantitative measure of severity. - The Authors.

Contribution of human short-wave cones to luminance and motion detection, by J. Lee and C.F. Stromeyer III (Division of Applied Sciences, Harvard University, Cambridge, MA 02138, USA), J. Physiol., 413, 563-593, 1989.

Human short-wave S cone signals are important for colour vision and here we examine whether the S cone signals also contribute to motion and luminance.

Detection was measured with moving patterns that selectively stimulated S cones - violet sine-wave gratings of 1 cycle deg-1 on an intense yellowish field. For rates up to 12 Hz, detection was governed by non-directional mechanisms, possibly of a chromatic nature, as shown by three findings: moving gratings had to be suprathreshold for their direction to be identified; the threshold ratio of counterphase flickering versus moving gratings was low; and direction-selective adaptation was essentially absent.

Evidence for less sensitive, directional mechanisms includes the following: at high velocity, the direction of movement of the violet gratings can be identified just slightly above the detection threshold; directional adaptation was strong with a suprathreshold test pattern; velocity was seen veridically for clearly suprathreshold patterns; and a counterphase flickering test, added in spatial-temporal quadrature phase to a similar suprathreshold mask, had identical detection and direction-identification thresholds.

Interactions of long-wave L cone and S cone signals in direction-selective mechanisms were measured with an orange counterphase grating and a violet counterphase test, both flickering at the same rate and presented in spatial quadrature phase on the yellowish adapting field. Direction identification thresholds, measured as a function of the temporal phase of two gratings, demonstrated both that the S cone signal lags considerably behind the L cone signal (an effect that strongly varies with S cone light

adaptation), and more strikingly, the S cone signal summates with a negative sign and thus is effectively inverted in direction-selective mechanisms.

Quantitatively similar temporal phase functions were obtained with uniform violet and orange flicker when a luminance discrimination criterion was used: thus the S cone signal summates negatively with the L cone signal for both discrimination of luminance flicker and the direction of motion.

The temporal phase functions accurately predicted threshold summation for identifying the direction of motion of a pair of violet and orange gratings moving with the same velocity but with different spatial phase offsets. Once the relative temporal phase lag of the S cones was compensated for, there was linear threshold summation for the violet and orange patterns when presented in effective (physiological) spatial antiphase, and clear cancellation when presented in phase. This and related experiments show a linear summation of S, M and L cone signals for direction detection, with the S cones having a negative sign. The luminance contrast sensitivity is very high for the spectrally long-wave member of the pair of gratings (300-500 at 8 Hz), suggesting that the patterns are detected with high-contrast sensitivity mechanisms such as the magnocellular pathway, which is known to have S cone input. The present measurements show that the contribution of the S cones to motion detection is only 1/30 - 1/50 that of the M and L cones, expressed in units of the cone contrasts of the component gratings. Thus the most sensitive mechanisms detecting rapid motion have a weak S cone input.

A sudden dimming of the yellowish adapting field strongly reduces the S cone, but not the M cone, input into the directional mechanisms. This 'transient tritanopia' suggests that S cone signals proceed through a spectrally antagonistic site before summation in directional mechanisms. - The Authors.

The effect of background luminance on cone sensitivity functions by T. Yeh, V.C. Smith and J. Pokorny (University of Chicago, Eye Research Laboratories, 939 East 57th Street, Chicago, IL 60637, USA). Invest. Ophthalmol. Vis. Sci. 30: 2077-2086, 1989.

Implementations of the Wald-Marré technique have employed fixed luminance backgrounds to isolate cone sensitivity mechanisms. We evaluated the effect of varying the adaptation level on the relative isolation of the different cone types. For MWS and LWS cone isolation we used a 15 Hz flickering test light to isolate the achromatic channel, and we modelled the resulting spectral sensitivity functions as a linear sum of LWS and MWS input. We found only mild improvement in relative cone isolation with increasing adaptation level. The LWS and MWS cone mechanisms showed decreasing sensitivity with adaptation level and reached limiting Weber behaviour above 1000 Td. SWS cones were isolated with a 2.4 Hz flickering light. SWS cone isolation improved with adapting level, reaching a plateau above 1000 Td. The SWS cone mechanism showed decreasing sensitivity with adaptation level but did not reach a limiting Weber region. Our data indicate that the use of fixed high adaptation levels has different effects on the cone mechanisms. Absolute sensitivity loss for LWS or MWS mechanism will not be revealed. LWS and MWS thresholds will appear normal unless there is an adaptation abnormality. On the other hand, the SWS cone thresholds would be sensitive to both absolute and increment sensitivity loss. More than one adaptation condition is needed to separate different types of sensitivity loss characteristic of eye disease. - The Authors

Regional IRGCVD Symposium
26-28th March 1990, Tokyo

Abstracts have been submitted for the following papers:

*M Takase and +M. Ikeda, *National Defence Academy, Yokosuka and +Tokyo Institute of Technology, Yokohama. **"COLOR APPEARANCE AT EXTRA-FOVEA STUDIED BY COLOR NAMING METHOD".**

M. Tsukamoto, E. Adachi-Usami and N. Fujimoto, Department of Ophthalmology, School of Medicine, Chiba University. **"COLOR VISION ESTIMATED COLOR REVERSAL VECPS IN PATIENTS WITH INTRAOCULAR LENS IMPLANT".**

Keiji Uchikawa and Hiroyuki Shinoda, Tokyo Institute of Technology Graduate School, Yokohama. **"EFFECTS OF COLOR MEMORY ON COLOR APPEARANCE".**

*Hiroko Terasaki, +Hiroshi Hirose and *Yuko Okada,*Nagoya University School of Medicine, +National Nagoya Hospital. **"STUDIES ON SWS CONE MECHANISM BY MEASURES OF THE PROBE-FLASH THRESHOLD".**

Jun Noki, Atsushi Kandatsu, Ryutaro Tamaki and Kenji Kitahara, Department of Ophthalmology, Jikei University School of Medicine. **"CHARACTERISTICS OF THE PANEL D-15 TEST IN OPTIC NERVE DISEASES WITH CONGENITAL RED-GREEN COLOR VISION DEFECTS".**

Kazuo Ichikawa, Department of Ophthalmology, Chukyo Hospital, Nagoya. **"THE COLOR SENSE OF PSEUDOPHAKIC EYES: CHROMATOPSIA".**

Mitsuru Sugimoto, Naotaka Miyamura and Yukitaka Uji, Department of Ophthalmology, Mie University School of Medicine. **"THE ERG RECORDING WITH HIGH SPEED SCANNING OF MONOCHROMATIC STIMULI".**

Y. Ejima, S. Takahashi and T. Kaihara, Kyoto University. **"ANALYSIS OF FEATURE EXTRACTION PROCESSING IN THE RED-GREEN SYSTEM".**

E. Adachi-Usami, E. Kato and M. Tsukamoto, Department of Ophthalmology, School of Medicine, Chiba University. **"COLOR VISION AND PATTERN REVERSAL VECPS IN A FAMILY OF DOMINANTLY INHERITED JUVENILE OPTIC ATROPHY".**

*Hanazaki Hidetoshi, +Tanabe Johji and +Kawasaki Kazuo, *Fukui Prefecture Saiseikai Hospital, Fukui. +Kanazawa University. **"ELECTRORETINOGRAPHIC FINDINGS IN CONGENITAL RED-GREEN COLOR DEFICIENCY".**

Andreas Bayer, University Eye Hospital, Tübingen. **"THE DIFFERENT ACTION OF ANTICONVULSANT DRUGS ON COLOR VISION".**

Eero Aarnisalo and Elina Vainio, Department of Ophthalmology, Satakunta Central Hospital, Pori, Finland. **"EFFECTS OF A BLUE FILTER GLASS ON THE AGE RELATED TRITAN TYPE COLOUR VISION DEFECT".**

Carol M. Cicerone, Department of Cognitive Sciences, University of California. **"COLOR APPEARANCE AND THE CONE MOSAIC IN TRICHROMACY AND DICHROMACY".**

XZ. Ku, WS. Zhang, XL. Li, WS. Liang, ZF. Yee and GH. He, Guangzhou Second Hospital, Guangzhou. **"THE INFLUENCE OF NOISE ON COLOUR VISION".**

Joel Pokorny, Vivianne C. Smith and Tsaiyao Yeh, Eye Research Laboratories, University of Chicago. **"ANALYSIS OF TRITAN DETECTION THRESHOLDS AND DISCRIMINATION ERRORS".**

Yoshinobu Nayatani, Osaka Electro-Communication University, Neyagawa. **"A RELATION ON BRIGHTNESS/LUMINANCE RATIO BETWEEN ILLUMINANT AND OBJECT COLORS".**

Stephen Dain, Janine Riley and Alison Steer, School of Optometry, University of New South Wales. **"THE EFFECT OF COLOUR VISION TEST DESIGN ON THE TRITAN DEFECT OBSERVED WITH SHORT DURATION STIMULI".**

J. D. Moreland, Department of Communication and Neuroscience, University of Keele. **"THE CLINICAL UTILITY OF ANOMALOSCOPY".**

H. Yaguchi, C. Monma, K. Tokunaga and Y. Miyake, Faculty of Engineering, Chiba University. **"COLOR APPEARANCE IN MESOPIC VISION".**

Shoji Kondo, Faculty of Engineering, Shinshu University. **"A COMPUTER SIMULATION OF ANOMALOUS COLOUR VISION".**

Makoto Isashiki, Yasuyuki Nakashima and Norio Ohba, Department of Ophthalmology, Kagoshima University Faculty of Medicine. **"RAYLEIGH MATCH AND VISUAL SENSITIVITY IN CENTRAL SEROUS CHOROIDOPATHY".**

H. Scheibner and Th. Kremer, Physiological Institute II, University of Düsseldorf. **"ASPECTS OF DEUTERANOMALOUS OPPONENT-COLOUR VISION".**

Joel Pokorny, The Eye Research Laboratories, University of Chicago. **"ACQUIRED COLOR DEFECT".**

A. Serra, S. Mulas and I. Zucca, Department of Ophthalmology, University of Cagliari. **"SOME REMARKS ON COLOUR DISCRIMINATION IN MULTIPLE SCLEROSIS".**

H. Ozaki, J. Yanase, T. Kasuga, A. Ogura and H. Joho, Product Development Laboratories, Yamanouchi Pharmaceutical Company Ltd, Tokyo. **"SPECTRAL SENSITIVITY OF CONE MECHANISM IN THE CYNOMOLGUS MONKEY STUDIED WITH LOCAL MACULAR ELECTRORETINOGRAM".**

Lucia R. Ronchi, Istituto Nazionale di Ottica, Florence. **"THE F-M 100 HUE TEST AS A TOOL IN A VISUAL LABORATORY".**

Du Li, Zhang Chengfen and Song Chen, Department of Ophthalmology, Beijing Union Medical College Hospital, Beijing. **"ABNORMAL HUED CONTRAST SENSITIVITY FUNCTION IN ACQUIRED COLOUR DEFECT".**

Peter Gouras, Department of Ophthalmology, College of Physicians and Surgeons of Columbia University, New York. **"MULTIPLEXING AND DEMULTIPLEXING CHROMATIC AND ACHROMATIC INFORMATION IN PRIMATE VISION".**

M. Marré and A. Pinckers, Medizinische Akademie Carl Gustav Carus, Dresden. **"ACQUIRED COLOR VISION DEFECTS IN DEPENDENCE ON DEPTH-LOCALIZATION AND FIXATION-ECCENTRISATION".**

A. Roth, Department of Ophthalmology, Cantonal University Hospital of Geneva. **"ARE METAMERIC COLOR EQUATIONS SUFFICIENT FOR THE CLINICAL DIAGNOSIS OF COLOUR VISION DEFICIENCIES?".**

Y. Ohta, H. Kudo, H. Hagiwara, A. Hanabusa and K. Saiki, Department of Ophthalmology, Tokyo Medical College. **"STUDIES ON COLOUR COMPENSATION TINTED SPECTACLE LENSES FOR PSEUDOPHAKIC PATIENTS".**

M. Tomonaga, Y. Ohta, K. Hamano and T. Motohashi, Department of Ophthalmology, Tokyo Medical College. **"COLOUR THRESHOLD OF THE MACULA WITHIN 3° FROM THE FOVEA IN COLOUR BLIND AND NORMAL SUBJECTS".**

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Meeting announcement...

Advances in Color Vision

May 1-12, 1990

Kellogg Eye Center
The University of Michigan
Ann Arbor, MI

The Department of Ophthalmology of the University of Michigan is sponsoring a symposium to honor Dr. Mathew Alpern on his 70th birthday. The invited speakers are:

Visual Pigments

Meredithe Applebury
Jeremy Nathans
Julie Schnapf

Non-invasive Assessment of Retinal Function

Don Hood
Paul Sieving

Cortical Mechanisms of Color Vision

Peter Lennnie
Russ DeValois
Semir Zeki
David Hubel

Human Color Psychophysics

Carol Cicerone
Steve Shevell
Vivianne Smith
Ed Pugh
David Krantz

Space is limited so reservations should be made early. For registration and information contact Carolyn Wurster (313-764-6468) at the Kellogg Eye Center, 1000 Wall Street, Ann Arbor, MI 48105. USA.