DALTONIANA

NEWSLETTER
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IRGCVD NEWS

Tübingen Symposium Proceedings

According to current membership records the following members are in good standing and will receive a copy of the Tübingen Symposium Proceedings automatically on publication. **All readers are strongly urged to check the list** and, if necessary, to advise their respective treasurer (Mrs J Birch or Dr B Drum) of omission or to bring their membership up to date in order to ensure entitlement to the Proceedings. An order form is appended to this issue for the Tübingen, Sydney and Cagliari proceedings.

Aarnisalo, Abraham, Abramov, Adams, Ahnelt, Akita, Alexander, Alvarez, Applegate, Arden, Backhaus, Bailey, Barker, Biersdorf, Billock, Birch, Bowman, de Brabandere, Bronte-Stewart, Buck, Burns, Capilla, Cavonius, Chan, Cicerone, Cobb, Cohen, BL Cole, Comerford, Crognale, Dain, Deeb, Derefeldt, Dessy, Devos, Dickinson, Drum, Eisner, Elsner, Eysteinsson, Fioretto, Fishman, Fletcher, Foster, Frederiksen, Frumkes, Fry, Fusco, Gerling, Gouras, Greenstein, Haegerstrom-Portnoy, Hahn, Hansen, Harris, Hart, Hedin, Hermès, Heron, Higgins, Hill, Hood, Hovis, Hukami, Hurvich, Illueca, Ishihara, Jacobs, Jaeger, Kaiser, Keunen, King-Smith, Kinnear, Kitahara, Knoblauch, Knox Laird, Krastel, A Kubo, H Kudo, Kulikowski, Kurtenbach, Lachenmayr, Lagerlöf, Lakowski, Lakshminarayanan, Lanthony, Lee, Leid, Leight, Lessel, Lingelbach, Littlewood, McKeefrey, MacLeod, Machemer, Majima, Mäntyjärvi, M Marré, Marshak, de Mattiello, Miyahara, Mollon, Montag, Mora-Ferrer, Moreland, Morland, Motulsky, Murakami, Naarendorp, Nagy, Nathans, Neitz, Nomura, Ohta, Parker, Paulus, Pease, Pellizzone, Pérez-Carpinell, Pidgeon, Pinckers, Plendl, Pokorny, Pollack, Reck, Reitner, DM Regan, Robbins, Robertson, Rositani-Ronchi, Roth, Rovamo, Roy, Rubin, Ruddock, Salu, Sample, Scheibner, Schneck, Serra, Shevell, Shimizu, Smith-Pokorny, Sperling, Steinschneider, Sternheim, Stockman, Swanson, Takahashi, Tamaki, Tanabe, Tausch, Teller, Terasaki, Toyoguchi, Tritsch, Uji, Usui, Uvijls, Valberg, Van Norren, Verdon, Vienot, Vingrys, Vogt, Voke, Wang, Wehrhahn, JS Werner, WD Wright, Yamade, Yasuma, Yeh, Yorke, Young, Zisman, Zrenner, Zwas, Zwick, Bibliloteca Interdipartimentale (Padova), Pennsylvania College of Optometry Library (Philadelphia), University Library (Houston).

Membership Subscriptions

The Treasurer has made arrangements with a U.K. bank to handle membership subscription by credit card. This will avoid the onerous changes levied by banks for foreign currency transactions. Arrangements will be in hand in 1994 for subscriptions to be paid through ACCESS, EUROCARD, MASTERCARD or VISA. All subscriptions formerly paid through Dr Bruce Drum and US banks should be channelled through the Treasurer, Mrs Jennifer Birch, who will announce details in due course.

IRGCVD Members Address List

The current members address list is included with this issue. Would members kindly check the address entered under their name and report any errors, ommissions or address changes to the Newsletter Editor (Professor J D Moreland).

LITERATURE SURVEY

The March and June 1993 issues of Eye Science have been received from China and some abstracts are reproduced here. Significant contributions, received from the Department of Experimental Psychology, University of Cambridge and from the Visual Sciences Center, University of Chicago, have been included in this issue. Minor editorial changes have been made to some abstracts.

Visual function and the subsequent development of exudative age-related macular degeneration. A EISNER, M L KLEIN, J D ZILIS and M D WATKINS. Invest. Ophthalmol. Vis. Sci., 1992, 33 (11), 3091-3102.

The eyes of 47 subjects with exudative age-related macular degeneration in the fellow eye were tested with a battery of visual function tests at baseline and followed for at least 18 mo. Fundus photographs also were obtained at baseline. These photographs were used to verify the absence of exudative lesions in the 47 eyes tested. Functional and funduscopic baseline data each were compared against outcome data obtained typically at 18 mo. The baseline data were analyzed for their ability to distinguish eyes that had developed detectable exudative age-related macular degeneration from eyes that had not. Eyes with relatively slow foveal dark adaptation rates despite low foveal quantum absorption capabilities (as inferred from the effects of test area on the Rayleigh color match) were especially likely to develop subretinal neovascularization. The resulting sensitivity/specificity and odds ratios were comparable to those of the most effective funduscopic risk indicators. Low S (blue) cone-mediated sensitivity also was associated with an exudative outcome.

La cataracte et la peinture de Claude Monet. Cataract and the painting of Claude Monet. (in French and English) P LANTHONY, Points de Vue, 1993, 29, 12-25.

"Monet is only an eye, but what an eye!" Cézanne is reputed to have said. Thus, when this eye was affected by a cataract, and later operated on, the painting of Monet underwent major changes. The present study has as its aim the analysis of these changes, in particular those concerning colours, which are the most evident. The method used has been based on colorimetric comparisons. The documentation is essentially drawn from the descriptive catalogue by Daniel Wildenstein, an indispensable work tool of exemplary rigour and precision.
We shall consider, successively:
1. The summarized medical history of Claude Monet's cataract.
2. The effect of the cataract.
3. The effects of aphakia on the vision and painting of Monet.
When discussing the effects of the cataract, one point should be made clear. From 1912 onwards, when Monet learned about his cataract, his right eye was already almost totally without vision. Thus, everything which will be said in this study concerning the evolution of the visual function of the eye affected by a cataract concerns the left eye; and it is precisely this change in the visual capacity of the left eye which led Monet to be operated on. But it was the right eye, the worst eye, which was operated on; and thus, all the following discussion about aphakic vision concerns the right eye.

Avico "Color Vision Analyzer": A new apparatus for different studies on human color vision. P CAPILLA and M AGUILAR. Clin. Vision Sci., 1993, 8 (2), 201-206.

We describe a prototype of a basic apparatus which can be put to varied use by connecting different modules or optical heads. The AVICO "Color Vision Analyzer" is based on the use of light emitting diodes (LEDs) as light sources and for the electronic control of parameters such as luminance, luminous modulation, flicker frequency, temporal modulation, etc. The most important functions are the "anomaloscope mode" for red-green anomalies and reductions and the "flicker mode" for different studies on the temporal properties of human visual system, but other applications are also possible. When we use AVICO as an anomaloscope, each observer determines the matching range limits (Rayleigh equation) where the yellow can be matched by luminance adjustment only. Pickfords' classification criteria have been used for diagnosis. When we use AVICO as a flicker apparatus, pure luminous flicker, pure chromatic flicker and hybrid flicker can be studied, and therefore, color and flicker fusion points can be determined.

Contributions from Eye Science

A fundus photographic method with narrow spectral band luminance. J QU, G WANG, Y TAO, F LU, M SHI, X LI and Y LING. Eye Science, 1993, 9, 45-48.

We perfected the narrow spectral band fundus photographic system using interference filters at the wavelengths of 417, 478, 500, 530, 547, 570, 589, 607, 628 and 648 nm. Tests about the light penetration of filters and exposure of various brand films were made on this system. Studies of the

contrast of fundal tissues and structures under the different narrow spectral band light were made on 43 Chinese fellow eyes. The results indicate that the interference filters of 570 nm have the highest light penetration. Kodak and Gongyuan films (made in China) are the optimal ones. Narrow spectral band fundus photography can eliminate chromatic aberration and therefore improve the documentation of fundal details, enhance the contrast of pictures as compared with routine white light fundus photography.

The clinical use of steady-state flash visual evoked potentials. (in Chinese) D-Z WU, Y LAI, L LU, L WU, J LIANG and Q ZHANG. Eye Science, 1993,9, 70-74.

The authors applied 30Hz flash stimuli to record steady-state flash visual evoked potentials (FVEP) and extracted the amplitudes and phases of the first and second harmonics as the characteristic value by discrete Fourier transform (DFT). 46 normal controls (89 eyes) and 78 patients (109 eyes) were detected and analysed by this method. The result showed that the characteristic values of the normal controls are significantly different in three age groups and showed the positive in 35 eyes with optic nerve diseases (82.9%), 25 eyes with age-related macular degeneration (92%), and 9 eyes with retinal detachment involved macular (100%). It indicates the method is a sensitive index to evaluate macular visual function. After preliminary observation, the visual acuities of postoperation were found above 0.4 in cataracts (28 eyes) or opacities (12 eyes) if preoperative FVEP were normal and non-complicated, or less than 0.4 if preoperative FVEP were abnormal. This suggests the method is one of the effective index to detect the postoperative vision of media opacities. The advantages, disadvantages and the clinical applications were discussed.

The multi-channel VEPs topography in optic neuritis. (in Chinese) K LIU, Z SONG, J HE and G ZUO. Eye Science, 1993, 9, 75-80.

The multi-channel VEPs topographies of 20 normal persons and 22 patients suffering from optic neuritis were recorded. In normal subjects, the topography showed symmetric distribution by full-field stimulation and paradoxical lateralization by half-field stimulation. In patients with optic neuritis, it showed asymmetric distribution most on the temporal side, some on the nasal side and occasionally in the middle by full-field stimulation. The result suggests that the optic nerve may be damaged on either temporal or nasal. The effect of the early diagnosis and evaluating treatment using topography is also discussed.

Clinical application of electro-retinographic C-wave. (in Chinese) X WEI and J YANG. Eye Science, 1993, 9, 81-84.

We studied electro-retinographic C-wave in several fundus diseases. Compared with the normal controls of 65 eyes, the amplitude extinguished and lowered respectively were 71.4% and 25% in retinal detachment (28 eyes), 72.5% and 22.5% in tapetal degeneration (40 eyes), 30.8% and 38.4% in uveitis (13 eyes), 18.2% and 50% in high myopia (22 eyes), 8.6% and 44.3% in diabetics (70 eyes). We conclude that the ERG-C-wave can be a very simple and practical method for helping the clinical diagnosis in several obscured fundus diseases, if the patient cooperates.

Contributions from Department of Experimental Psychology, University of Cambridge.

Serine/alanine amino acid polymorphism of the L and M cone pigments: effects on Rayleigh matches among deuteranopes, protanopes and color normal observers. E SANOCKI, D T LINDSEY, J WINDERICKX, D TELLER, S DEEB and A G MOTULSKY. Vision Research, 1993, 33, 2139-2152.

The Seattle group has previously shown that there is an association between the Rayleigh matches of colour-normal subjects and the amino acid at position 180 in their long-wave opsin: those whose genes exhibit the codon for serine at this position require less red in their match than do those whose long-wave gene codes for alanine at the corresponding position. The present paper examines the same polymorphism in dichromats. Nine deuteranopes were selected on the basis that (a) they appeared to have only a single long-wave gene and (b) did not exhibit non-homologous substitutions at sites other than 180. Brightness matches were obtained for different R/G ratios on a Nagel anomaloscope with primaries 541, 591, 644 nm. Five deuteranopes with serine at site 180 exhibited a steeper (positive) slope of brightness against R/G than did four deuteranopes with alanine at this position. Modelling suggested that a 4.3nm shift of the residual long-wave pigment would account for the average difference between the two groups of deuteranopes. Only one of eleven protanopes had serine at site 180, but this subject exhibited the shallowest (negative) slope of brightness against R/G, suggesting that his residual middle-wave pigment was shifted to slightly longer wavelengths.

Further data are presented for normals, confirming that substitution of serine for alanine affects Rayleigh matches for both 2-deg and 8-deg fields - J D Mollon.

A study of women heterozygous for colour deficiencies. G JORDAN and J D MOLLON. Vision Res., 1993, 33 (11), 1495-1508.

We have examined the colour vision of 43 female subjects in the age range 30-59 yr of whom 31 were obligate carriers of various forms of colour deficiency and the rest were women who had no known colour-deficient relatives. In the case of all the carriers we established the phenotypes of their colour-deficient sons. As a group, carriers made significantly more errors on the Ishihara plates and showed enlarged matching ranges on the Nagel anomaloscope, but we could not replicate earlier reports of increased error scores on the Farnsworth-Munsell 100-Hue test of systematic shifts in Rayleigh match mid-points. We did find that the colour matches of carriers of deuteranomaly were significantly displaced from those of normals in a ratio-matching task in which a mixture of 546 and 600 nm was matched with a mixture of 570 and 690 nm. Owing to X-chromosome inactivation, women who are heterozygous for anomalous trichromacy ought to have at least four types of cone in their retinae and we ask whether this affords them an extra dimension of colour vision, by analogy to New World monkeys where heterozygous females gain trichromacy in a basically dichromatic species. Many carriers of anomalous trichromacy exhibited no evidence for tetrachromacy, in that they accepted large-field Rayleigh matches following a rod bleach and they were unable to set unique matches in our ratio-matching task. However, eight carriers of anomalous trichromacy - and no other subject - refused large-field Rayleigh matches; and we found one carrier of deuteranomaly who was apparently able to make unique matches in the ratio-matching task.

The Nagel anomaloscope and seasonal variation of colour vision. G JORDAN and J D MOLLON. Nature, 1993, 363, 546-549.

In 1948 the German physicist, Manfred Richter, reported that colour vision has a seasonal variation. For four colour-normal subjects, he found a sinusoidal variation in the proportion of red and green required to match a monochromatic yellow, the equation known as the "Rayleigh match". In summer, subjects required more red in their mixture. The measurements were made with the Nagel anomaloscope, an instrument introduced in 1907 and which today, essentially unchanged, remains the definitive clinical instrument for classifying the many phenotypic variations in colour vision. The variation that Richter recorded in the red-green ratio was large (three Nagel units), and it now takes on fresh interest because it is comparable in size to the difference in Nagel settings later reported between normal observers of different genetic types. We have been able to replicate Richter's result, but report here that it is almost certainly instrumental: the Nagel anomaloscope proves to be very sensitive to ambient temperature.

Contributions from Visual Sciences Center, University of Chicago

Luminance and chromatic modulation sensitivity of macaque ganglion cells and human observers. B B LEE, J POKORNY, V C SMITH, P R MARTIN and A VALBERG. J. Opt. Soc. Am. A., 1990, 7 (12), 2223-2236.

We measured the sensitivity of macaque ganglion cells to luminance and chromatic sinusoidal modulation. Phasic ganglion cells of the magnocellular pathway (M-pathway) were the more sensitive to luminance modulation, and tonic ganglion cells of the parvocellular pathway (P-pathway) were more sensitive to chromatic modulation. With decreasing retinal illuminance, phasic ganglion cells' temporal sensitivity to luminance modulation changed in a manner that paralleled psychophysical data. The same was true for tonic cells and chromatic modulation. Taken together, the data suggest strongly that the cells of the M-pathway form the physiological substrate for detection of luminance modulation and the cells of the P-pathway the substrate for detection of chromatic modulation. However, at high light levels, intrusion of a so-called luminance mechanism near 10 Hz in psychophysical detection of chromatic modulation is probably due to responses in the M-pathway, arising primarily from a nonlinearity of cone summation. Both phasic and tonic ganglion cells responded to frequencies higher than can be psychophysically detected. This suggests that central mechanisms, acting as low-pass filters, modify these cells' signals, though the corner frequency is lower for the P-pathway than for the M-pathway. For both cell types, the response phase at different frequencies was consistent with the cells' description as linear filters with a fixed time delay.

Stiles-Crawford effect and color matching in Stargardt's Disease. J E E KEUNEN, V C SMITH, J POKORNY and M B METS. Am. J. Ophthalmol., 1991, 12 (2) 216-217.

We measured the Stiles-Crawford effect and performed color matching on a patient with Stargardt's disease (fundus flavimaculatus). Both psychophysical techniques demonstrated gross abnormalities

at the level of the foveal photoreceptors in a fairly early stage of the disease. These data confirm the results of a study on foveal densitometry in Stargardt's disease, in which impaired foveal cone photopigment kinetics were found at an early stage.

Responses of macaque ganglion cells to the relative phase of heterochromatically modulated lights. V C SMITH, B B LEE, J POKORNY, P R MARTIN and A VALBERG. J. Physiol., 1992, 458, 191-221.

1. We measured the response of macaque ganglion cells to sinusoidally modulated red and green lights as the relative phase, θ, of the lights was varied.
2. At low frequencies, red-green ganglion cells of the parvocellular (PC-) pathway with opponent inputs from middle-wavelength sensitive (M-) and long-wavelength sensitive (L-) cones were minimally sensitive to luminance modulation (θ = 0 deg) and maximally sensitive to chromatic modulation (θ = 180 deg). With increasing frequency, the phase, θ, of minimal amplitude gradually changed, in opposite directions for cells with M- and L-cone centres.
3. At high frequencies (at and above 20 Hz), phasic cells of the magnocellular (MC-) pathway were maximally responsive when θ ≈ 0 deg and minimally responsive when θ ≈ 180 deg, as expected from an achromatic mechanism. At lower frequencies, the phase of minimal response shifted, for both on- and off-centre cells, to values of θ intermediate between 0 and 180 deg. This phase asymmetry was absent if the centre alone was stimulated with a small field.
4. For PC-pathway cells, it was possible to provide an account of response phase as a function of θ, using a model involving three parameters; phases of the L- and M-cone mechanisms and a L/M cone weighting term. For red-green cells, the phase parameters were monotonically related to temporal frequency and revealed a centre-surround phase difference. The phase difference was linear with a slope of 1-3 deg Hz^{-1}. If this represents a latency difference, it would be 3-8 ms. Otherwise, temporal properties of the M- and L-cones appeared similar if not identical. By addition of a scaling term, the model could be extended to give an adequate account of the amplitude of responses.
5. We were able to activate selectively the surrounds of cells with short-wavelength (S-) cone input to their centres, and so were able to assess L/M cone weighting to the surround. M- and L-cone inputs added linearly for most cells. On average, the weighting corresponded to the Judd modification of the luminosity function although there was considerable inter-cell variability.
6. To account for results from MC-pathway cells, it was necessary to postulate a cone-opponent, chromatic input to their surrounds. We developed a receptive field model with linear summation of M- and L-cones to centre and surround, and with an additional M, L-cone opponent input to the surround. It proved possible to account for response phase and amplitude of both on- and off-centre cells. For both, the proposed cone-opponent input to the surround must consist of a (+ M - L) mechanism.
7. The dependence of minimum response of MC-pathway cells on θ closely resembles psychophysical results obtained using the same protocol, in which psychophysical modulation sensitivity was measured as a function of θ. The results provide strong corollary evidence linking the MC-pathway to psychophysical performance in heterochromatic flicker photometry.

Full-spectrum cone sensitivity functions for X-chromosome-linked anomalous trichromats. P DEMARCO, J POKORNY and V C SMITH. J. Opt. Soc. Am. A., 1992, 9 (9), 1465-1476.

We derived the cone fundamentals for X-chromosome-linked anomalous trichromats for the wavelength range of 400-700 nm. Pigment templates were constructed from the cone fundamentals of normal trichromats after correction for ocular media absorption. The resultant retinal-level sensitivities had small irregularities in the short-wavelength region that were smoothed. The pigment templates, expressed as quantal sensitivities, were then shifted on a frequency abscissa to solve for the λ_{max} of the pigments of anomalous trichromats needed to predict average anomaloscope matching data. We found that the protanomalous M- and L'-cone pigments are separated by 10 nm and the deuteranomalous M'- and L-cone pigments are separated by 6 nm (rounded to the nearest nanometer), where M and L indicate middle- and long-wavelength sensitive, respectively. The triads of peak wavelengths for the corneal energy-based sensitivities were as follows: normal: 440, 543 and 566 nm; protanomalous: 440, 543 and 553 nm; and deuteranomalous: 440, 560 and 566 nm.

How surrounds affect chromaticity discrimination. E MIYAHARA, V C SMITH and J POKORNY. J. Opt. Soc. Am. A., 1993, 10 (4), 545-553.

Chromatic discrimination thresholds were measured with and without surrounds along two cardinal axes of chromaticity space. On one axis the level of short-wavelength-sensitive (SWS)-cone excitation was varied for constant long-wavelength-sensitive (LWS)-cone and medium-wavelength-sensitive (MWS)-cone excitations, and on the other axis there were equal and opposite changes in LWS-cone and MWS-cone excitations for constant levels of SWS-cone excitation. Results for two of three observers showed that with a dark surround, discrimination mediated by SWS cones was regulated by the level of SWS-cone excitation of the starting chromaticity, showing a function with the form of a

threshold-versus-radiance function. For an equiluminant white or yellow surround, the discrimination for all three observers showed a minimum at the level of SWS-cone excitation of the surround, giving a V-shaped function for the white surround. An additional experiment with dimmer white surrounds indicated that while the minimum remained at the white point, the function gradually changed toward the shape with a dark surround. Discrimination thresholds mediated by LWS and MWS cones with a dark surround showed a minimum near the LWS-cone excitation of equal-energy white, giving a V-shaped function. The effect of yellow and white surrounds was to deepen the V. The data can be described by a model of chromatic discrimination incorporating a threshold term, a cone gain control, and an opponent gain control into two equations, one for SWS-cone discrimination and one for LWS-cone and MWS-cone discrimination.

Spectral-luminosity functions, scalar linearity, and chromatic adaptation. J POKORNY, Q JIN and V C SMITH. J. Opt. Soc. Am. A, 1993, 10 (6), 1304-1313.

We report data for three experiments that assess the effect on the luminosity function of chromatic adaptation arising from the measurement stimuli. First, we report spectral-sensitivity functions (wavelength range, 510-640 nm) measured by heterochromatic flicker photometry for a luminance range of 25-5000 Td. The data were fitted to a linear combination of cone fundamentals. The data narrowed and the fits deteriorated with an increase in luminance level, which indicates that at high luminances chromatic adaptation that is dependent on the spectral composition of the standard and test lights is a factor in spectral-luminosity determination. Second, we report heterochromatic modulation photometry as measured with two spectral lights at constant time-averaged chromaticity and luminance for luminances from 1.6 to 1300 Td. For a time-averaged chromaticity of 570 nm, the red-green ratio of the photometric match was invariant with luminance. For a time-averaged chromaticity of 605nm, the red-green ratio increased by almost 0.3 log unit for a 2-log-unit increase in luminance, which is indicative of chromatic adaptation to the 605-nm chromaticity. Third, we measured flicker increment detection (wavelength range, 510-640 nm) on 570- and 605-nm backgrounds of 25-5000 Td. The data were fitted to a linear combination of cone fundamentals and showed good fits at all luminances. Fits to the 570-nm-background data set showed little variation in the proportions of the cone fundamentals with luminance. Fits to the 605-nm-background data set required an increased weighting of the middle-wavelength-sensitive cone with luminance. These three experiments indicate that luminance-dependent variation in the spectral-luminosity function as assessed by flicker techniques is caused primarily by chromatic adaptation to the measurement stimuli.

Luminance. P LENNIE, J POKORNY and V C SMITH. J. Opt. Soc. Am. A, 1993, 10 (6), 1283-1293.

Luminance was introduced by the CIE as a photometric analog of radiance. This implies that an additive spectral-luminosity function characterizes the human observer. In practice, many different spectral-sensitivity functions characterize human vision, although few produce the additive spectral-luminosity function V(λ), which is suitable for use in practical photometry. Methods that give rise to additive spectral-sensitivity functions that most resemble V(λ) tend to have in common the use of spatial or temporal frequencies that will discriminate against signals from the short-wavelength-sensitive cone pathways or against signals in other chromatic pathways. Some of the difference among results obtained with different techniques seems to reflect the extent to which the methods can bring about changes in the state of chromatic adaptation, but it also seems likely that not all tasks tap the same postreceptoral mechanisms. Psychophysical evidence is equivocal regarding the nature of the postreceptoral mechanisms: some evidence suggests just three mechanisms, one which has a spectral sensitivity that is like V(λ); other evidence suggests the existence of multiple mechanisms with different spectral sensitivities. Physiological recordings from neurons in the macaque's visual pathway suggest that the properties of the magnocellular system may be sufficient to account for spectral-sensitivity functions measured with the techniques of heterochromatic flicker photometry, minimally distinct border, and critical flicker fusion. These are the psychophysical methods that yield spectral sensitivities that are most like V(λ). Other methods of measuring spectral sensitivity seem more likely to depend on signals that travel through the parvocellular system.

Chromatic discrimination with variation in chromaticity and luminance: Data and theory. T YEH, J POKORNY and V C SMITH. Vision Res., 1993, 33 (13) 1835-1845.

Boynton and Kambe developed a model of chromatic discrimination in which thresholds are mediated by two independent mechanisms: the short-wavelength sensitive (S-) cones (S-cone axis), and the middle-wavelength sensitive (M-) and long-wavelength sensitive (L-) cones (M/L-cone axis). In this study, we used a Maxwellian view optical system to investigate fundamental properties of the model as a function of chromaticity and luminance. We confirmed that discriminations along the S-cone axis were dependent on S-cone excitation level. However, changes in chromaticity and

individual differences. Interobserver differences in the wavelength of peak sensitivity of photopigment (λ_{max}) are of primary interest because they are attributed to an X-chromosome-linked polymorphism. Color-matching equations, however, show the Rayleigh match cannot distinguish between interobserver differences in λ_{max} and interobserver differences in the optical density of photopigment. Further analysis of color-matching equations reveals that the ratio of two particular Rayleigh-type matches amplifies the effect of individual differences in the λ_{max} of L cones relative to the effects of optical density and pre-receptoral spectrally selective filtering. The ratio of these two color matches was measured for 17 color-normal males. The range of the results for the 17 observers is too large to be explained by only individual differences in photopigment optical density and pre-receptoral filtering. This implies there are interobserver differences in λ_{max}. The results are accounted for quantitatively by a small difference (3-5 nm) in the λ_{max} of the L-cone photopigment. The ratio of two Rayleigh-type matches is a rapid and convenient measurement for assessing the L-cone λ_{max} in the eye of an individual observer and therefore may be useful for classifying normal trichromats into phenotypic sub-types - The Authors.

Serine/alanine amino acid polymorphism of the L-cone photopigment assessed by dual Rayleigh-type color matches. E SANOCKI, S K SHEVELL and J WINDERICKX. Vision Res., 1994, 34 (3), 377-382.

The dual Rayleigh-type color match is the ratio of 621 nm light to 550 nm light that in admixture matches 586 nm light, divided by the ratio of 667 nm light to 550 nm light that in admixture matches 586 nm light. Compared to the classical Rayleigh match, the dual-match procedure minimizes variation in color matching arising from differences in lens pigmentation and photopigment optical density, and thus amplifies individual differences due to shifts in L pigment λ_{max}. We hypothesized that the dual matches would provide a clearer distinction between subjects with serine and subjects with alanine than would the classical Rayleigh match because individuals with serine express L pigments with a λ_{max} shifted toward longer wavelengths than do those with alanine. Classical Rayleigh color matches were compared with dual Rayleigh-type color matches in 14 color-normal observers whose DNA had been analyzed previously for the presence of the amino acid serine or alanine at position 180 in the L opsin. The resulting distribution of dual-match measurements for the seven subjects with serine does not overlap the distribution of measurements for the seven subjects with alanine. The classical Rayleigh-match measurements for these two groups of subjects, on the other hand, overlap substantially. More than half of the subjects' classical Rayleigh matches are within the overlapping range. The dual Rayleigh-type matches, therefore, provide an improved psychophysical technique for assessing whether an individual observer has serine or alanine at position 180 - The Authors.

Visual field deficits in early age-related macular degeneration. M J TOLENTINO, S MILLER, A R GAUDIO and M A SANDBERG. Vision Res., 1994, 34 (3), 409-413.

Patients with early age-related macular degeneration (AMD) may retain good visual acuity but experience distortion and other qualitative visual changes. The purpose of the present study was to determine whether deficits of form recognition, as well as of light sensitivity, were related to retinal pigment epithelial (RPE) atrophy and/or drusen. We assessed form recognition deficits by the Amsler grid and by a perimetric test of letter recognition and sensitivity deficits by the macular threshold test of the Humphrey Field Analyzer in 59 patients with AMD and visual acuities of 20/40 or better. The number of defects on each test was compared with the area of RPE atrophy and with the area of drusen determined from fundus photographs. Multiple regression analyses based on ordinal data revealed that the number of visual field defects by each test was significantly correlated with the area of atrophy, but not with the area of drusen. There was also no significant tendency for a patient with regional preponderance of drusen to have more impairment in the corresponding visual field. These results suggest that deficits of form recognition, as well as of sensitivity, in patients with early stages of AMD can be attributed to alteration of photoreceptor function associated with RPE atrophy, but not with drusen - The Authors.

Mechanisms of chromatic rod vision in scotopic illumination. U STABELL and B STABELL. Vision Res., 1994, 34 (8), 1019-1027.

After viewing a coloured patch for 30 sec, successive contrast colours were triggered by stimulating either rods or cones. The conditions were arranged so that the rod and cone stimuli matched both with respect to chromaticness and brightness in a chromatically neutral state of adaptation. The results showed that the contrast colours triggered by rods were strikingly similar to those triggered by cones. Yet, the scotopic contrast colours, as compared with the photopic ones, were generally found to be somewhat displaced toward blue. This displacement was attributed to the difference in test conditions. Thus, it was suggested that, although rods may excite all the different types of spectrally opponent cells, they generally tend to prefer the short-wave cells. Moreover, it was concluded that

Spectral transmission and short-wave absorbing pigments in the fish lens I. Phylogenetic distribution and identity. A THORPE, R H DOUGLAS and R J W TRUSCOTT. Vision Res., 1993, 33 (3) 289-300.

Spectral transmission and short-wave absorbing pigments in the fish lens II. Effects of age. A THORPE and R H DOUGLAS. Vision Res., 1993, 33 (3), 301-307.

Transient and sustained components of the pupillary responses evoked by luminance and color. R S L YOUNG, B-C HAN and P-Y WU. Vision Res, 1993, 33 (4), 437-446.

That the pupil reacts to changes in luminance and color, as well as to spatial features in the retinal image raises questions about whether phasic and tonic and/or color and luminance visual pathways project to the pretectal pupillomotor neurons. The present study compares pupillary responses evoked by heterochromatic and achromatic luminance increments to investigate whether the pupillary responses evoked by color and by luminance are independent of one another. Principal component analysis is used to examine the constituents of the pupil responses. The results support the belief that the visual input to the pupillomotor system is organized into phasic and tonic (but not necessarily independent color and luminance) pathways - The Authors.

Photopigments and color vision in the nocturnal monkey, *Aotus*. G H JACOBS, J F DEEGAN II, J NEITZ, M A CROGNALE and M NEITZ. Vision Res, 1993, 33 (13): 1773-1783.

The owl monkey (Aotus trivirgatus) is the only nocturnal monkey. The photopigments of Aotus and the relationship between these photopigments and visual discrimination were examined through (1) an analysis of the flicker photometric electroretinogram (ERG), (2) psychophysical tests of visual sensitivity and color vision, and (3) a search for the presence of the photopigment gene necessary for the production of a short-wavelength sensitive (SWS) photopigment. Both electrophysiological and behavioural measurements indicated that in addition to a rod photopigment the retina of this primate contains only one other photopigment type - a cone pigment having a spectral peak ca 543 nm. Earlier results that suggested these monkeys can make crude color discriminations are interpreted as probably resulting from the joint exploitation of signals from rods and cones. Although Aotus has no functional SWS photopigment, hybridization analysis shows that Aotus has a pigment gene that is highly homologous to the human SWS photopigment gene - The Authors.

Transient and sustained components of the pupil response evoked by achromatic spatial patterns. R S L YOUNG and J KENNISH. Vision Res, 1993, 33 (16), 2239-2252.

The present study provides new clues about visual processes underlying the human pupillary responses evoked by achromatic spatial patterns. The pupillary responses can be modelled as a combination of two processes, a temporally transient process which saturates with increasing contrast and a temporally sustained process which varies linearly with increasing grating contrast. The transient process has low-pass, whereas the sustained process has a middle band-pass spatial filter characteristic. The results support the hypothesis that the visual input to the pupillomotor nuclei is composed of phasic and tonic visual neurons that are functionally similar to those in the magno (M)- and parvo (P)- cellular layers in the lateral geniculate nucleus - The Authors.

Brightness matching and colour discrimination in young diabetics without retinopathy. A KURTENBACH, U WAGNER, A NEU, U SCHIEFER, M B RANKE and E ZRENNER. Vision Res., 1994, 34 (1), 115-122.

This study used the methods of the Farnsworth-Munsell 100-hue test (FM-100), heterochromatic brightness matching (HBM) and wavelength discrimination to test the sensitivity and colour vision of 20 juvenile diabetics with no (16) or very mild (4) retinopathy. Their results were compared to an age-matched control group. The FM-100 results showed a significant increase in error scores throughout the spectrum in comparison to the controls. This deterioration in colour vision was confirmed in the results for the wavelength discrimination task, tested between 440 and 640 nm, where the just noticeable difference in colour was, in general, larger for the diabetic group than the control group. Only at 460 nm were the results of the diabetics similar to those of the controls. The diabetic group were also less sensitive than the control group in the HBM task between 480 and 600 nm. The results show that a deficit in sensitivity and colour vision occurs in diabetics before the onset of a clinically visible retinopathy - The Authors.

Individual differences in cone photopigments of normal trichromats measured by dual Rayleigh-type color matches. J-C HE and S K SHEVELL. Vision Res., 1994, 34 (3), 367-376.

Individual differences in color matches of normal trichromats are well documented. Recently, varients of the classical Rayleigh match have been measured to explore the cause(s) of these

be judged by the Directorial Committee and the prize for the winner (if any) will be free registration to the next Symposium in Pau in 1995.

LITERATURE SURVEY

More than three different cone pigments among people with normal color vision. J NEITZ, M NEITZ and G H JACOBS. Vision Res, 1993, 33 (1): 117-122.

A fundamental feature of normal color vision is that red and green lights can be mixed to appear identical with a monochromatic yellow light. Another characteristic of normal color vision is that people often disagree on the amounts of red and green needed in the mixture to exactly match the yellow. Comparison of such color vision differences with photopigment gene differences reveals that a serine/alanine polymorphism at amino acid position 180 of X-encoded pigments can account for this type of color vision variation. This amino acid change shifts the spectrum of the pigment produced by about 6 nm, a value that would predict a larger minimum color vision difference between individuals than is actually observed. This discrepancy can be explained if, counter to the Young-Helmholtz theory of trichromacy, many people with normal color vision have more than three spectrally different cone pigments - The Authors. (minor editing)

Red-green color discrimination in peripheral vision. A L NAGY and S WOLF. Vision Res, 1993, 33 (2): 235-242.

Color discrimination thresholds were measured for four colors from the red-green portion of the visible spectrum. Thresholds were measured for a stimulus field 1.5 deg in diameter in the fovea and at three locations on the nasal retina (eccentricities of 5, 20 and 40 deg). Outside the fovea thresholds increased exponentially with eccentricity and the slope of the function was similar for all four standard colors. Peripheral thresholds were adequately described by an equation developed for foveal red-green thresholds by Boynton and Kambe [(1980) Color Research and Applications, 5, 13-23] and also by a modified form of this equation containing a rod term. Differences between foveal and peripheral thresholds were characterized by changes in two coefficients in the equations. The CIELUV color difference equation also provided a reasonably good description of peripheral thresholds - The Authors.

Genetic basis of polymorphism in the color vision of Platyrrhine monkeys. G H JACOBS, J NEITZ and M NEITZ. Vision Res., 1993, 33 (3), 269-274.

It was earlier proposed that the polymorphism of color vision observed in some neotropical monkeys could be accounted for by assuming that these animals have only a single photopigment gene locus on the X-chromosome. Three kinds of evidence have been added to existing data sets in an effort to evaluate the adequacy of the single locus model: (1) photopigment complements of squirrel monkeys (Saimiri sciureus) have been determined using electroretinogram flicker photometry; (2) photopigment pedigrees have been established for several families of squirrel monkey; (3) X-chromosome pigment genes obtained from six dichromatic monkeys (three squirrel monkeys; three tamarins - Saguinus fuscicollis) have been examined to search for sequence polymorphisms at those gene loci believed crucial for spectral tuning. All of these results are in accord with the idea that some species of platyrrhine primate have only a single type of photopigment gene on the X-chromosome - The Authors.

Spatial and chromatic interactions in the human pattern electroretinogram. M KORTH, N X NGUYEN, R RIX and O SEMBRITZKI. Vision Res., 1993, 33 (3), 275-287.

The spectral sensitivity and the spatial selectivity was studied both psychophysically and electroretinographically using the pattern onset-offset paradigm. All measurements were made under intensive yellow adaptation. The spectral sensitivity functions of both measures were in close agreement. They showed a peak at 460 nm (blue-sensitive mechanism) and a shoulder around 550 nm (red-green-sensitive mechanism). The luminance curves of the pattern onset ERG obtained with long wavelengths had a steeper slope and reached larger amplitudes than those obtained with short wavelengths. In addition the response-peak times were longer with short wavelengths. When the spatial frequency of the pattern was varied the 460 nm-onset responses showed very little or no spatial tuning and long peak times (around 60 msec). This was ascribed to the contribution from only one type of ganglion cell, namely the blue-yellow opponent receptive fields lacking a center-surround organization. The 550 nm-onset responses showed a clear spatial tuning (4 c/deg) and an increase in peak time (40-50 msec) with increasing spatial frequency (0.26-9.2 c/deg). This was ascribed to different types of receptive fields having a center-surround structure - The Authors.