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NEWSLETTER
OF THE INTERNATIONAL RESEARCH GROUP ON COLOUR VISION DEFICIENCIES

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IRGCVD NEWS

Tübingen Symposium Proceedings

The publishers Kluwer inform us that proofs will be sent out to authors after 21 June 1994. Would authors please note that corrected proofs should be returned by mid-July to Dr. Bruce Drum, 4932 Pale Orchis Court, Columbia, MD 21044, USA. If all proceeds smoothly, the anticipated publication date will be September 1994.

Publication of Future Proceedings

Your committee has been actively pursuing alternative publication possibilities for our Symposium Proceedings. There has been an exciting new development recently in our discussions with a high profile research journal which we hope soon to bring to a conclusion. This would increase the exposure of the IRGCVD to the wider vision community. Another, not inconsequential benefit, could be a dramatic reduction in the IRGCVD full-membership fee. Members may have been wondering why they have not received their usual notice for membership renewal from the Treasurer. This renewal notice has been postponed pending the aforementioned negotiations.

Literature Survey Appeal

We have increased journal coverage in the current survey. However, a measure of selectivity has been introduced: some citations being in title only. We record here our debt to those members who have provided the survey with reviews and with copies of their own papers and we thank them most warmly.

Continuation of the survey is becoming more difficult in the face of advancing draconian cuts in journals taken by UK University libraries. The success and utility of the survey is becoming increasingly dependent on help from you, our members. We strongly urge you to support our efforts with reviews, citations and with copies of publications.

Prize for a Shorter Name

The wish has been expressed by some members for the name of the Group to be replaced by a shorter one. "International Research Group on Colour Vision Deficiencies" is not a name which readily lends itself to conversation between colleagues. Abbreviations such as "IRG" or "Research Group", which are used colloquially, are inappropriate outside the Group. A few suggestions have been made, but with one exception which had the unfortunate acronym of AIDS, these did not meet with an enthusiastic response. Member's suggestions for a new name should be sent to The Editor. They will

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changes in mean luminance were not described by a single threshold-vs-radiance (TVR) template. We developed a model to account for the different effects of changing S-cone excitation by varying mean chromaticity and by varying mean luminance. M/L-cone discriminations showed a minimum at the L-cone excitation to white, indicating strong opponency. The thresholds increased with luminance approaching a Weber region and showing parallel functions for differing chromaticities. These data are fit by a model allowing retinal gain controls and spectral opponency.

Colorimetric purity discrimination: Data and theory. T YEH, V C SMITH and J POKORNY. Vision Res., 1993, 33 (13), 1847-1857.

Colorimetric purity, measured as the first step from white toward the spectrum has a V-shaped function. Purity discrimination is best near 400 nm, least at 570 nm and intermediate at mid-spectrum and long wavelengths. A much flatter function occurs when colorimetric purity is measured as the first step from the spectrum toward white. In this study, we applied the formulation of chromatic discrimination thresholds measured along the S-cone and M/L cone axis to account for chromatic discrimination in the equiluminant plane. The modeling results show that the purity step from white has a 1.6 log unit calculated range, similar to the classical data. The purity step from the spectrum is much flatter. The predicted range is dependent on the individual variance in chromatic discrimination thresholds and the luminance level. We then used psychophysical procedures to test the model's predictions. The resulting purity discrimination functions were generally in agreement with the model. Our modeling indicates that discrepant data of colorimetric purity can be explained in the context of discrimination models.

Pigment test evaluated by a model of chromatic discrimination. V C SMITH, J POKORNY and T YEH. J. Opt. Soc. Am. A, 1993, 10 (8), 1773-1784.

Clinical color-vision tests are evaluated within the framework of a model of chromatic discrimination in terms of cone excitation. The motivation for this study was to derive a method for evaluation of test design, test sensitivity, and observer performance. The discrimination model is based on the assumption that chromatic discrimination is mediated in two independent channels, one for short-wavelength cones and one for long- and middle-wavelength cones. Luminance-dependent templates are derived for each channel, and they describe chromatic-discrimination behavior of the young color-normal observer. The templates incorporate receptor- and opponent-level gain controls. We show how the chromaticities of clinical tests can be calculated in cone excitation units and how discrimination behavior on the tests can be plotted on the templates. The tests include the Farnsworth-Munsell 100-hue, the Farnsworth Panel D-15, the Farnsworth Panel D-15 desaturated, the American Optical Hardy-Rand-Rittler, the Farnsworth F_2 plate, the Standard Pseudoisochromatic Plates, Part II, the Ishihara and the Minimalist tests. Clinical-test data collected on young color-normal observers at different illumination levels show the validity of the techniques.

the scotopic successive contrast colours are triggered by rod signals feeding into the primary rod pathway and therefore must originate centrally to the receptor level - The Author.

Seeing depth in colour: More than just what meets the eyes. J FAUBERT. Vision Res, 34 (9), 1165-1186.

Novel binocular depth illusions obtained from two-dimensional colour images are presented. It is demonstrated that the magnitude of these illusions is based on transverse chromatic aberration (TCA), however, the depth obtained cannot be observed unless specific conditions are met even if the TCA is present. Some form of perceptual organization occurring at and/or beyond the binocular fusion site of the brain, is required for some of these effects to occur. An example of a paradoxical finding leading to this conclusion is the observation that under some conditions the same colour can be perceived on separate depth planes while spatially adjacent colours from opposing ends of the visible spectrum (i.e. red and blue or green) can be perceived on the same depth plane simultaneously within the same image. Further, results show that some form of reference plane is required by the brain to use the colour induced disparity, without which, depth cannot be perceived even if the disparity information is present. This phenomenon is spatially tuned for medium to high frequency components and is still detectable under isoluminant conditions which would support the notion that it requires information from the parvocellular pathway. Binocular lustre and rival depth are ruled out as being significant factors in the effect. It is argued that this phenomenon represents an instance of global interactive processes induced by TCA while previous studies on chromostereopsis have concentrated on local aspects. Results of the present study may explain why under certain situations depth can be perceived in coloured images and not under other circumstances where TCA is still present - The Author.

Luminance noise and the rapid determination of discrimination ellipses in colour deficiency. B C REGAN, J P REFFIN and J D MOLLON. Vision Res., 1994, 34 (10), 1279-1299.

A computer-controlled test of colour vision is described, in which luminance noise and masking contours are used to ensure that the subject's responses depend on chromatic signals. The test avoids the need - common to most computer-controlled tests - to define equiluminance for the individual subject before the colour test itself can be administered. The test achieves a good separation of protan and deutan subjects and reveals the large range of chromatic sensibilities among anomalous trichromats. As a population, dichromats had higher thresholds on the tritan axis of the test than did normals. In an extension of the test, full discrimination ellipses were measured for normal and colour-deficient observers. The nature of anomalous trichromacy is discussed and the possibility is raised that hybrid genes, resulting from genetic recombination, may code for incorrectly labelled or functionally impaired molecules - The Authors.

VISION RESEARCH: Special Issue
The Biology of Ultraviolet Reception, 1994, 34 (11), 1359-1540.

Section 1

An analysis of two spectral properties of vertebrate visual pigments. F I HAROSI.

Ultraviolet filter compounds in human lenses: 3-hydroxykynurenine glucoside formation. A M WOOD and R J W TRUSCOTT.

The fate of ultraviolet receptors in the retina of the Atlantic salmon (*Salmo salar*). Y W KUNZ, G WILDENBURG, L GOODRICH and E CALLAGHAN

Spectral characteristics of visual pigments in rainbow trout (*Onchorhynchus mykiss*). C W HAWRYSHYN and F I HAROSI

Ultraviolet visual pigments in marine fishes of the family pomacentridae. W N McFARLAND and E R LOEW

The developmental trajectory of ultraviolet photosensitivity in rainbow trout is altered by thyroxine. H I BROWMAN and C W HAWRYSHYN

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Ultraviolet vision in a passeriform bird: from receptor spectral sensitivity to overall spectral sensitivity in *Leiothrix lutea*. E J MAIER

The photopic sensitivity of the yellow field of the pigeon's retina to ultraviolet light. J J VOS HZN, M A J M COEMANS and J F W NUBOER

A third, ultraviolet-sensitive, visual pigment in the Tokay gecko (Gekko gekko). E R LOEW

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Ultraviolet receptors and color vision: evolutionary implications and a dissonance of paradigms T H GOLDSMITH

Ultraviolet as a component of flower reflections, and the colour perception of hymenoptera. L CHITTKA, A SHMIDA, N TROJE and R MENZEL

Biological aspects of bird colouration and avian colour vision including ultraviolet range. E FINGER and D BURKHARDT

Wavelength discrimination of the goldfish in the ultraviolet spectral range. C FRATZER, S DÖRR and C NEUMEYER

Ultraviolet regulation of neuroendocrine and circadian physiology in rodents. G C BRAINARD, F M BARKER, R J HOFFMAN, M H STETSON, J P HANIFIN, P L PODOLIN and M D ROLLAG

Small passerines can discriminate ultraviolet surface colours. E N DERIM-OGLU and V V MAXIMOV

Mapping cone photopigment optical density. A E ELSNER, S A BURNS and R H WEBB. J Opt Soc Am A, 1993, 10 (1): 52-58.

The distribution of cone photopigment across the retina affects the amount of light captured by cones at each retinal location. Cone photopigment optical density is measured in two ways, with reflectometry and/or with color matching. Color matching measures a higher optical density than does reflectometry. Control experiments confirm that large-field color matches measure photopigment optical density toward their outer edge. There is qualitative agreement as to photopigment distribution from both techniques near the fovea. Beyond 1 deg, color matching indicates little decrease in photopigment with increasing eccentricity, whereas retinal densitometry shows a steep decline in photopigment. The decrease in perifoveal optical density measured with reflectometry is attributed to the decrease in cone coverage from fovea to perifovea as rods and interphotoreceptor spaces increase. Differences among subjects in photopigment distribution near the fovea, measured with both techniques, reflect differences in the specialization of the foveal centre

for cone length and/or photopigment concentration per cone, which are factors influencing results from both techniques - The Authors.

Colour matching at high illuminances: photopigment optical density and pupil entry. S A BURNS and A E ELSNER. J Opt Soc Am A, 1993, 10 (2): 221-230.

Changes in the effective optical density of the cones are sufficient to explain changes in color matches with retinal illuminance and pupil entry. We performed three experiments. In the first experiment, six observers made color matches under both bleached and unbleached conditions to a series of six standard wavelengths. The effects of bleaching could be modelled by a decrease in optical density of the L and M cone photopigments. Slight spectral shifts in the peak wavelengths of the photopigments were required for different observers. In the second experiment we varied retinal illuminance of the color-matching field from 2.4 to 5.4 log Td for a series of long-wavelength primaries. The shape of the color match versus the intensity function was unchanged by the wavelength composition of the matching field. In the third experiment we measured the change in color match with retinal illuminance for different pupil entry positions. At low luminances there was a marked dependence of the color match on pupil entry positions. At high illuminance there was only a small dependence. The halfbleach illuminance values varied as expected from the Stiles-Crawford I effect. We conclude that for wavelengths > 540 nm, changes in color matches with bleaching and pupil entry can be explained by changes in the effective optical density of the cones - The Authors.

Red-green color discrimination as a function of stimulus field size in peripheral vision. A L NAGY and J A DOYAL. J Opt Soc Am A, 1993, 10 (6): 1147-1156.

Red-green color-discrimination thresholds were measured at eccentricities of 10 and 25 deg in the nasal retina. Thresholds were measured as a function of stimulus field size both during the cone plateau and after dark adaptation. During the cone plateau, threshold decreased with increasing field size, but the effect of field size was dependent on the color of the test stimulus. The decrease in threshold was greater for yellow and orange test stimuli than for red and green tests. Two factors, summation and opponent-mechanism adaptation, appear to affect the relation between threshold and field size. An equation suggested by Boynton and Kambe in 1980 [Color Res. Appl. 5, 13, (1980)] provides a good description of the variation in thresholds with field size and eccentricity. After dark adaptation, thresholds increased for all test colors, suggesting that rod signals reduce discrimination. The dark-adapted thresholds could be described well by the addition of a rod term to the Boynton-Kambe equation - The Authors.

Optics of the harbor porpoise eye in water. R H H KRÖGER and K KIRSCHFELD. J Opt Soc Am A, 1993, 10 (7): 1481-1489.

Isolation of the middle- and long-wavelength-sensitive cones in normal trichromats. A STOCKMAN, D I A MacLEOD and J A VIVIEN. J Opt Soc Am A, 1993, 10 (12): 2471-2490.

Spectral sensitivity in the red-green spectral range typically reflects the joint influence of the middle-wavelength-sensitive cones (the M or green cones) and long-wavelength-sensitive cones (the L or red cones). The balance of M- and L-cone influence can be altered by presenting the test lights superimposed upon steady background fields of long or short wavelength. We find that presenting test stimuli just after an abrupt exchange between two colored backgrounds permits an easier and closer approach to cone isolation than presenting them either on a steady background or following an intense bleach. Background exchange drives the flicker detection or flicker photometric spectral sensitivities measured at 17 Hz to a limiting condition at lower intensities than do steady backgrounds. This condition is consistent with either M- or L-cone isolation. Steady backgrounds do not produce complete cone isolation: even on backgrounds that push spectral sensitivity closest to M or L, there are substantial phase differences between flickering lights of different color. In contrast, no phase differences remain following background exchange. The improvement in cone isolation produced by the exchange procedure is not confined to flicker measurements: the spectral range over which subjects are temporarily monochromatic is more extended following background exchange than on steady fields - The Authors.

Spectral sensitivities of the human cones. A STOCKMAN, D I A MacLEOD and N E JOHNSON. J Opt Soc Am A, 1993, 10 (12) : 2491-2521.

Transient chromatic adaptation produced by an abrupt change of background color permits an easier and closer approach to cone isolation than does steady-state adaptation. Using this technique, we measured middle-wave-sensitive (M-) cone spectral sensitivities in 11 normals and 2 protanopes and long-wavelength-sensitive (L-) cone spectral sensitivities in 12 normals and 4 deuteranopes. Although there is great individual variation in the adapting intensity required for effective isolation,

there is little variation in the shape of the M- and L-cone spectral-sensitivity functions across subjects. At middle and long wavelengths, our mean spectral sensitivities agree extremely well with dichromatic spectral sensitivities and with the M- and L-cone fundamentals of Smith and Pokorny [Vision Res 15, 161 (1975)] and of Vos and Walraven [Vision Res 11, 799 (1971)], both of which are based on the CIE (Judd-revised) 2° color-matching functions (CMF's). But the agreement with the M-cone fundamentals of Estévez [Ph.D. dissertation, Amsterdam University (1979)] and of Vos et al [Vision Res 30, 936 (1990)], which are based on the Stiles-Burch 2° CMF's, is poor. Using our spectral-sensitivity data, tritanopic color-matching data, and Stiles's π_3, we derive new sets of cone fundamentals. The consistency of the proposed fundamentals based on either the Stiles-Burch 2° CMF's or the CIE 10° large-field CMF's with each other, with protanopic and deuteranopic spectral sensitivities, with tritanopic color-matching data, and with short-wave-length-sensitive (S-) cone spectral-sensitivity data suggests that they are to be preferred over fundamentals based on the CIE 2° CMF's - The Authors.

Lens-equivalent age controls for diabetics. J D MORELAND. Invest Ophthalmol Vis Sci, 1993, 34 (2): 281-282. (Journal Letter).

Foveal ganglion cell loss is size dependent in experimental glaucoma. Y GLOVINSKY, H A QUIGLEY and M E PEASE. Invest Ophthalmol Vis Sci, 1993, 34 (2): 395-400.

Measuring vision with temporally modulated stripes in infants and children with ROP. O KATSUMI, J K KRONHEIM, M C MEHTA, Y MATSUI, H TETSUKA and T HIROSE. Invest Ophthalmol Vis Sci, 1993, 34 (3): 496-502.

A second box-end scoring artifact in the Farnsworth-Munsell 100-hue test. B J CRAVEN. Invest Ophthalmol Vis Sci, 1993, 34 (3): 503-506.

Purpose. *To investigate and describe a hitherto unreported scoring artifact in the Farnsworth-Munsell 100-hue Test, arising from the grouping of the caps into four boxes, which causes caps near the ends of a box to score less than caps near the centre of a box. This artifact is in addition to a previously reported one, which causes caps near the end of a box to score more than caps in the centre of the box.*
Methods. *Two different statistical simulations were used to generate synthetic cap sequences, which were scored in the normal way.*
Results. *For error scores less than about 500, the new artifact, which depresses scores at the ends of boxes, was found to dominate the pattern of scores.*
Conclusion. *The existing published correction for the box-end scoring artifact is inappropriate for scores less than about 500, and therefore should be applied cautiously - The Author.*

A model for the observer on the Farnsworth-Munsell 100-hue test. B J CRAVEN. Invest Ophthalmol Vis Sci, 1993, 34 (3): 507-511.

Purpose. *To use a theoretical model of the observer on the Farnsworth-Munsell 100-hue test to estimate the magnitude of random variation in 100-hue test error scores.*
Methods. *The model was based upon classical signal detection theory. Results from the model were obtained by computer simulation.*
Results. *There is a fairly regular relationship between mean test scores over many tests and the standard deviation of those scores. This relationship is for practical purposes unaffected by polarity in the observer's hue discrimination and by changes in the detailed assumptions of the model.*
Conclusion. *The model provides a flexible tool for further theoretical research into the 100-hue test - The Author.*

Incremental light detection thresholds across the central visual field of human albinos. R V ABADI and E PASCAL. Invest Ophthalmol Vis Sci, 1993, 34 (5): 1683-1690.

Purpose. *The authors investigated central retinal function in albinism by measuring incremental light detection thresholds in a group of oculocutaneous human albinos.*
Methods. *Eleven oculocutaneous human albinos (six tyrosinase negative and five oculocutaneous positive), six patients with idiopathic congenital nystagmus, and six normal control subjects participated in the study. Using a Goldmann bowl perimeter, incremental light detection thresholds were measured in the vertical meridian across the central ± 30° of the retina. Target presentation times were 1 sec for all subjects, and in the case of four albinos and one patient with idiopathic nystagmus, they were limited to the low-velocity period of each nystagmus cycle.*
Results. *For the normal control subjects, the maximum sensitivity was found to be -0.60 ± 0.10 log units. By comparison, at 0°, a range of sensitivities was obtained from the albino subjects (-0.9 to -2.1 log units) and from those with idiopathic nystagmus (-0.7 to -1.9 log units). The albinos had diverse retinal sensitivity profiles ranging from a near-normal peaked curve to a flat homogeneous profile. A*

variety of sensitivity profiles was also detected in those with idiopathic nystagmus, although, compared with the albino curves, a greater proportion were peaked. No sensitivity differences were found between the short and the longer target presentations.
Conclusions. *The variety of retinal sensitivity profiles obtained in this study suggests that, in albinism, considerable intersubject variability in the degree of foveal hypoplasia exists and that albino "foveal" function can reach near-normal levels, for at least some visual tasks - The Authors.*

Magnification perimetry. K LATHAM, D WHITAKER, J M WILD and D B ELLIOTT. Invest Ophthalmol Vis Sci, 1993, 34 (5): 1691-1701.

Stereochemistry of the human macular carotenoids. R A BONE, J T LANDRUM, G W HIME, A CAINS and J ZAMOR. Invest Ophthalmol Vis Sci, 1993, 34 (6): 2033-2040.

Senile cataract progression studies using the lens opacities classification system II. B V MAGNO, M B DATILES III and S M LASA. Invest Ophthalmol Vis Sci, 1993, 34 (6): 2138-2141.

The human S-cone electroretinogram and its variation among subjects with and without L and M-cone function. P GOURAS, C J MacKAY and S YAMAMOTO. Invest Ophthalmol Vis Sci, 1993, 34 (8): 2437-2442.

Purpose. *To examine the S-cone ERG in subjects with and without L and M-cone function.*
Methods. *Ganzfeld spectral flashes in the presence of strong Ganzfeld adapting fields are used to elicit S-cone ERGs.*
Results. *The S-cone ERG b-wave ranges from 0.2 to 4 mV in amplitude and 38-45 msec in implicit time. There is a progressive decrease in amplitude with age. The response is similar in subjects with or without L and M cone function.*
Conclusion. *The S-cone ERG is detectable in subjects of all ages, but intersubject variability limits its diagnostic usefulness. The S-cone ERG is slightly later than but does not appear to be obviously influenced by the L and M-cone ERG - The Authors.*

Fluorometric assessment of equivalent healthy lens age for people with diabetes. M LARSEN. Invest Ophthalmol Vis Sci, 1993, 34 (9): 2607. (Journal Letter).

Sites of cone system sensitivity loss in retinitis pigmentosa. W H SEIPLE, K HOLOPIGIAN, V C GREENSTEIN and D C HOOD. Invest Ophthalmol Vis Sci, 1993 (9): 2638-2645.

Purpose. *To examine the sites of cone sensitivity loss in patients with retinitis pigmentosa by comparing focal electroretinographic and psychophysical modulation thresholds.*
Methods. *Both psychophysical and electrophysiologic increment threshold curves were obtained in retinitis pigmentosa patients and a group of age-matched, normally-sighted adults.*
Results. *The majority of the retinitis pigmentosa data could be accounted for by a vertical displacement of the normal curve. The retinitis pigmentosa patients showed similar patterns of cone sensitivity losses using both techniques.*
Conclusions. *The combined electrophysiologic and psychophysical results provide support for an outer retina locus for these cone sensitivity losses. The data suggest that these deficits may be caused by a spatially independent loss of cone photoreceptors with normal adaptation properties in the remaining photoreceptors - The Authors.*

Mechanisms mediating visual detection in static perimetry. R S HARWERTH, E L SMITH III and L DeSANTIS. Invest Ophthalmol Vis Sci, 1993, 34 (10): 3011-3023.

Purpose. *The usual stimuli in static perimetry are white-light luminance increments. However, the specific visual detection mechanisms involved in perimetry are unknown because all classes of neural mechanisms are sensitive to spectrally broadband stimuli. The objective of this study was to determine the relative sensitivities of non-opponent and opponent detecting mechanisms under standard perimetry test conditions.*
Methods. *Using trained rhesus monkey subjects, the relative sensitivities of the vision mechanisms for the detection of perimetry test stimuli were determined through psychophysical measurements of spectral sensitivity at each of the test field locations of the C24-2 threshold program on the Humphrey Field Analyzer (Allergan Humphrey, San Leandro, CA). The spectral sensitivity functions were analyzed by a three-channel model that incorporated independent short-wavelength-sensitive, non-opponent (luminance), and opponent (chromatic) spectral sensitivity mechanisms.*
Results. *The visual detection mechanisms for perimetry thresholds varied as a function of the size and wavelength of the test field. With the perimeter's standard stimulus (Goldmann Size III) and bowl illumination (31.5 asb), the presence of a short-wavelength-sensitive mechanism was clearly evident at all field locations, but its relative sensitivity systematically declined with eccentricity. Under these*

conditions, the sensitivities of the opponent and non-opponent mechanisms were approximately equal at most field locations. With a larger stimulus (Goldmann Size V), however, the contribution of the opponent spectral sensitivity mechanism was more apparent over most of the central field and the alterations of sensitivity with eccentricity were less pronounced. In contrast, a small test field (Goldmann Size II) appeared to bias detection toward non-opponent mechanisms.
Conclusion. *The results of these investigations indicate that detection thresholds during perimetry can be effectively biased toward different photopic, visual processing channels through the appropriate selection of size and wavelength of the test stimulus - The Authors.*

S-cone function in patients with retinitis pigmentosa. W H SWANSON, D G BIRCH and J L ANDERSON. Invest Ophthalmol Vis Sci, 1993, 34 (11): 3045-3055.

Purpose. *To determine whether short-wavelength-sensitive (S-) cones are more severely damaged in patients with retinitis pigmentosa than long-wavelength-sensitive (L-) and middle-wavelength-sensitive (M-) cones. To determine whether there are differences in the amount of S-cone damage in patients with dominant versus non-dominant inheritance patterns. To accomplish these goals with methods that provide information not furnished by previous studies with two-color increment thresholds.*
Methods. *Acuity mediated by the S-cones was measured in 56 patients with retinitis pigmentosa, and the electroretinogram (ERG) generated by the S-cones was measured in 11 of these patients. Mixed L- and M-cone acuity, mixed L- and M-cone ERGs, and clinical full-field rod and cone ERGs were obtained for all patients. Data for both dominant and non-dominant patient groups were compared with data from age-matched normal subjects.*
Results. *Only the non-dominant group had reduced S-cone acuity, and 43% of patients in this group had selective reduction of S-cone acuity. In this particular sample the dominant and non-dominant groups were comparable in clinical full-field ERG parameters and mixed L- and M-cone acuity, so the difference in S-cone acuities is not due to the dominant group having less advanced retinal degeneration. All 11 patients tested had reduced S-cone ERGs, 6 with significantly greater loss in the S-cone ERG than in the mixed L- and M-cone ERG.*
Conclusions. *These data provide evidence that retinitis pigmentosa can produce greater loss of S-cones than L- and M-cones, and that this selective loss is primarily seen in patients with non-dominant forms of retinitis pigmentosa - The Authors.*

Temporal modulation perimetry: The effects of aging and eccentricity on sensitivity in normals. E J CASSON, C A JOHNSON and J M NELSON-QUIGGS. Invest Ophthalmol Vis Sci, 1993, 34 (11), 3096-3102.

Resistance of diabetic rat electroretinogram to hypoxemia. T RIMMER and R A LINSENMEIER. Invest Ophthalmol Vis Sci, 1993, 34 (12), 3246-3252.

Negative electroretinograms in retinitis pigmentosa. A V CIDECIYAN and S G JACOBSON. Invest Ophthalmol Vis Sci, 1993, 34 (12), 3253-3263.

Aging of the human photoreceptor mosaic: Evidence for selective vulnerability of rods in central retina. C A CURCIO, C L MILLICAN, K A ALLEN and R E KALINA. Invest Ophthalmol Vis Sci, 1993, 34 (12) 3278-3296.

Purpose. *Because previous studies suggested degeneration and loss of photoreceptors in aged human retina, the spatial density of cones and rods subserving the central 43° of vision as a function of age was determined.*
Methods. *Cones and rods were counted in 27 whole mounted retinas from donors aged 27 to 90 years with macroscopically normal fundi. Photoreceptor topography was analyzed with new graphic and statistical techniques.*
Results. *Changes in cone density throughout this age span showed no consistent relationship to age or retinal location, and the total number of foveal cones was remarkably stable. In contrast, rod density decreased by 30%, beginning inferior to the fovea in midlife and culminating in an annulus of deepest loss at 0.5 to 3 mm eccentricity by the ninth decade. Space vacated by dying rods was filled in by larger rod inner segments, resulting in a similar rod coverage at all ages. At the temporal equator, cone density declined by 23%, but rods were stable throughout adulthood.*
Conclusions. *The stability of both rod coverage and rhodopsin content despite decreasing cell number suggests plasticity of the adult rod system and that age-related declines in scotopic sensitivity may be due to postreceptoral factors. There is no evidence for the massive loss of foveal cones required to explain even modest decrements in acuity, consistent with evidence that visual deficits at high photopic levels may be largely due to optical factors. Why the rods of central retina, which share a common support system and light exposure with the neighboring cones, are preferentially vulnerable to aging remains to be determined - The Authors.*

Foveal cone ERGs in fellow eyes of patients with unilateral neovascular age-related macular degeneration. M A SANDBERG, S MILLER and A R GAUDIO. Invest Ophthalmol Vis Sci, 1993, 34 (12), 3477-3480.

Sensitivity in the nasal and temporal hemifields in children treated for cataract. E R BOWERING, D MAURER, T L LEWIS and H P BRENT. Invest Ophthalmol Vis Sci, 1993, 34 (13), 3501-3509.

Motion perception in glaucoma. M A BULLIMORE, J M WOOD and K SWENSON. Invest Ophthalmol Vis Sci, 1993 (13), 3526-3533.

Characteristics of frequency-of-seeing curves in normal subjects, patients with suspected glaucoma, and patients with glaucoma. B C CHAUHAN, J D TOMPKINS, R P LEBLANC and T A McCORMICK. Invest Ophthalmol Vis Sci, 1993, 34 (13), 3534-3540.

Quantal and visual efficiency of fluorescence in the lens of the human eye. T J T P VAN DEN BERG. Invest Ophthalmol Vis Sci, 1993, 34 (13), 3566-3573.

Effect of aging on retinal macular microcirculation: A blue field simulation study. J E GRUNWALD, J PILTZ, N PATEL, S BOSE and C E RIVA. Invest Ophthalmol Vis Sci, 1993 34 (13), 3609-3613.

Influence of pathologic scotopization on the extended Rayleigh Match. M MARRÉ and A PINCKERS. Documenta Ophthalmologica, 1993, 85: 55-66.

Pathologic scotopization, an important symptom of retinal disease, can be studied by means of the Nagel II anomaloscope. This method is called the micro-screw method. The micro-screw method was performed in 14 congenital and 13 acquired colour vision defective individuals. The method proves to be useful in detecting symptoms of rod intrusion in colour vision under photopic conditions - The Authors.

> **Editor's Note:** The "micro-screw" on the Nagel II anomaloscope rotates the telescopic arm and, thereby, changes the wavelengths of all three stimuli. Thus the test wavelength was changed from 597 to 678 nm in 12 approximately equal increments, simultaneously changing the two primaries from 597 to 678 nm and from 531 to 582 nm respectively. With test luminance fixed at the mean appropriate to the colour match for 10 normals, subjects were required to make their best matches by varying only the primary mixture.

Colour vision in retinitis pigmentosa. Influence of cystoid macular edema. A PINCKERS, A VAN AAREM and J E E KEUNEN. International Ophthalmology, 1993, 17: 143-146.

In retinitis pigmentosa patients the effect of cystoid macular edema on colour vision was studied. The occurrence of cystoid macular edema decreases with increasing colour vision defect. The mutual proportion of the main types of colour vision defects remains stable until visual acuity has dropped to 0.5; at lower VA levels the number of red-green defects increases. Neither the finding of a blue-yellow colour vision defect in FM 100 Hue testing nor the appearance of anomaloscopic pseudoprotanomaly is influenced by cystoid macular edema. The authors conclude that cystoid macular edema in retinitis pigmentosa patients mainly affects visual acuity and not colour vision. They also noted a familial occurrence of cystoid macular edema - The Authors.

Evaluation du panel D-15 désaturé. III. Evaluation de la validité du panel D-15 désaturé. (Assessment of desaturated Panel D-15. III. Evaluation of the validity of the desaturated Panel D-15). P LANTHONY. J Fr Ophtalmol, 1994, 17 (1), 15-21.

The estimation of the validity of a test refers to whether this test measures what it claims to measure. The validity of the desaturated panel D-15 was estimated in 248 subjects with congenital hereditary dyschromatopsia. The method used was based on a qualitative and quantitative study of the so-called lines of confusion joining the positions of the colored caps on the classical Farnsworth's diagram. The qualitative estimation was evaluated according to the prevailing number of lines of confusion which were parallel to a given line of reference of the diagram; it was related to the axis of the dyschromatopsia. The comparison of the results with results of Nagel's anomaloscope used as a reference test, demonstrated an overvaluation of the number of the protan subjects (anomaloscope: 77; desaturated D-15: 107) and an undervaluation of the number of deutan subjects (anomaloscope: 169; desaturated D-15: 70). This kind of discrepancy was not apparent with the standard Panel D-15.

The quantitative estimation was evaluated according to the whole number of lines of confusion whatever their directions; it was related to the severity of the dyschromatopsia. The comparison of the results with the results of Nagel's anomaloscope demonstrated that the dichromatic and extreme anomalous trichromatic subjects nearly always (40 subjects out of 42) had 7 lines of confusion, or more; the simple anomalous trichromatic subjects had a variable number of lines of confusion, from 1 to 8, without any prevalence in the great majority of cases (193 subjects out of 204). There was an overlap between dichromatic and simple anomalous trichromatic subjects at the level of 7 and 8 lines of confusion. The conclusion were as follows:- qualitatively, the desaturated D-15 was able to indicate the deutan axis, but not the protan axis of some dyschromatopsias;- quantitatively, the separation between simple anomalous trichromatism and dichromatism (or extreme anomalous trichromatism) was confirmed fairly correctly at the level of 7 lines of confusion with Cohen's K equal to 0.58 - The Author.

New color perception data in peripheral retina II: influence of vision field size. M M PÉREZ, A YEBRA, M J RIVAS and E HITA. Atti Fond G Ronchi, 1994, 2, 427-436.

A new data set has been obtained in order to study the influence of the field size on color perception in the peripheral retina. This work was made with three different field sizes (0.5, 1 and 2°) and for three observers. Curves of frequency of seeing have been obtained with the help of methods which have been already used in previous works. According to the results, the color perception was better under greater field sizes. Color perception in peripheral retina could be explained by a defective color vision model, even for the studied greater field sizes: the difference among them is that the zone with a certain deutan tendency moves towards the periphery on increasing the field size - The Authors.

Thomas Young: Biographic notes. R CECCHINI, M G CUCCHI and G PELOSI. Atti Fond G Ronchi, 1994, 2, 457-477.