DALTONIANA

NEWSLETTER
OF THE INTERNATIONAL RESEARCH GROUP ON COLOUR VISION DEFICIENCIES

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Correction and Apology

In the June 1992 Issue of Daltoniana, No. 75, Dr Dorothea Jameson's name was inadvertently replaced in the IRGCVD Members Address List by Mrs Dorothea J. Hurvich-Jameson. The editor apologizes unreservedly for this mistake and for any apparent disrespect towards a most distinguished colleague.

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1992 Stiles Lecture

The 1992 Stiles Lecture will be given by Dr Jeremy Nathans (John Hopkins University, Baltimore) at 5.30 p.m. on Thursday, 15th October 1992, at University College London. The subject of the lecture will be the genes that encode the retinal photopigments.

Reviews Contributed by Dr J D Mollon

Design, chemical synthesis, and expression of genes for the three human color vision pigments. D D OPRIAN, A B ASSENJO, N LEE and S L PELLETIER. Biochemistry, 1991, 30, 11367-11372.

This paper describes the first in vitro preparation of human cone pigments. The authors have chemically synthesized analogues of the opsin genes and have incorporated them in a tissue-culture preparation of monkey kidney cells, where the genes express the corresponding proteins. When the proteins are purified and combined with 11-cis-retinal, they prove to have absorption curves similar to those expected for the short-, middle- and long-wave pigments - thus giving direct confirmation that the genes identified by Nathans and collaborators do indeed code for cone opsins. A clever twist is that the genes used are not identical to the human ones, but instead incorporate silent substitutions

that do not change the amino acids coded for, yet do provide unique restriction sites that will later allow the genes to be easily altered and the consequences of particular mutations examined.

Detection of gene alteration for color vision defects by polymerase chain reaction. Q ZHANG, W MAO, Q MA, R ZENG, L WU, D WU and Y CHEN. Eye Science, 1992, 8, 8-11.

In order to allow daltonism to be detected in the foetus, the authors propose a rapid method of screening DNA for abnormalities of the genes for the long- and middle-wave opsins. They use the polymerase chain reaction (a method of quickly producing many copies of a stretch of DNA encompassed by two short "primer" sequences). Their primers are chosen to amplify exon five of the long- and of the middle-wave gene, which is the region in which the two genes most differ in the amino-acid sequence they code for. The DNA is then cut into fragments of varying size by means of enzymes specific for particular patterns in the DNA sequence, and the presence of long-wave and middle-wave genes are inferred from the differently sized fragments that result. [The eugenic overtones in this paper will be strange to the Western reader, especially to those who suspect colour deficiency may be maintained by a heterozygous advantage.]

Polymorphism in red photopigment underlies variation in colour matching. J WINDERICKX, D T LINDSEY, E SANOCKI, D Y TELLER, A G MOTULSKY and S S DEEB. Nature, 1992, 356, 431-433.

This is a very significant paper in that it traces much of the variance of normal colour matches to specific genetic differences between observers. Rayleigh matches and DNA samples were obtained from 50 males. Observers with serine at position 180 in the amino-acid sequence of the long-wave opsin are found to be more red-sensitive (ie. needed less red in their Rayleigh match) than those with alanine at that position. [Similar results were reported by Neitz, Neitz and Jacobs at the recent meeting in honour of R Boynton (Opt. Soc. Amer. Tech. Digest, 1992, 4., 14-16, although the latter authors believe that a site-180 polymorphism of the middle-wave opsin also contributes substantially to the variation in normal matches]

Absorption spectra of human cone pigments. S L MERBS and J NATHANS. Nature, 1992, 356, 433-435.

This paper complements the preceding one. cDNA for the human cone opsins was expressed in a tissue-culture preparation, and the photopigments were reconstituted by adding 11-cis retinal. Absorption spectra for the purified pigments were measured before and after bleaching. Two alternative forms of the long-wave opsin were expressed, differing in whether alanine or serine was present at site 180: the two reconstituted pigments differed in the direction (if not the magnitude) expected, having maximal sensitivities at 552 and 557 nm respectively. The difference spectra for the short- and middle-wave pigments had maximal sensitivities at 426 and 530 nm respectively.

Defective colour vision associated with a missense mutation in the human green visual pigment gene. J WINDERICKX, E SANOCKI, D T LINDSEY, D Y TELLER, A R MOTULSKY and S S DEEB. Nature Genetics, 1992, 1, 251-255.

Hitherto, most red/green colour deficiencies have been found to be associated not with local mutations of the opsin genes but with gross rearrangements that yield hybrids of the long- and middle-wave genes. This paper reports a male who exhibits severe deuteranomaly (Nagel range 12-68, deutan brightness settings) and who appears to have a substitution of arginine for cysteine at position 203 in the amino-acid sequence of the middle-wave opsin. This substitution would be expected to have a serious effect on the conformation of the protein, since the cysteine at 203 (lying in the second extracellular loop of the molecule) is thought normally to form a disulphide bond with the cysteine at position 126 (in the first extracellular loop). Apparently all three of the subject's copies of the middle-wave gene are affected. The same substitution was found in other subjects - one colour-normal and one simple deuteranomalous - but they also exhibited middle-wave genes without this substitution; so the authors suggest that the altered middle-wave gene is not expressed when it lies in the distal part of the opsin gene cluster, i.e. furthest from the long-wave gene. [Two interesting problems are raised by this paper: since all the proband's middle-wave genes are thought to be defective, how does he come to enjoy some red-green discrimination? And what genetic event has led to his having three copies of a gene with the same deletion?]

Human tritanopia associated with two amino acid substitutions in the blue-sensitive opsin. C J WEITZ, Y MIYAKE, K SHINZATO, E MONTAG, E ZRENNER, L N WENT and J NATHANS. American Journal of Human Genetics, 1992, 50, 498-507.

This is the first paper to report a molecular basis for tritanopia. In four out of nine unrelated tritanopic probands, a point substitution was found in the gene that codes for the short-wave opsin. One substitution, in exon 1, leads to the replacement of glycine by arginine at site 79 in the corresponding amino-acid sequence, a site that lies in the second transmembrane domain of the molecule. All homozygotes for this substitution were affected but heterozygotes could be affected or not affected. The second substitution, in exon 3, leads to the replacement of serine by proline at site 214, a site that lies in the fifth transmembrane domain of the molecule. Most heterozygotes for this substitution were affected. No examples of the mutations were seen in samples of 43 and 84 control subjects respectively.

Human tritanopia associated with a third amino acid substitution in the blue-sensitive visual pigment. C J WEITZ, L N WENT and J NATHANS. American Journal of Human Genetics, 1992, 51, 444-446.

A third substitution in the gene for the short-wave opsin is reported. This substitution in exon 4 leads to the replacement of proline by serine at position 262 in the amino-acid sequence of the molecule, a site in the sixth transmembrane region of the protein. This substitution was found in four cases of tritanopia but not in any of 64 controls. The affected individuals were heterozygous for the substitution.

Variations in retinal degenerations. M L APPLEBURY. Current Biology, 1992, 2, 113-115.

A short, authoritative review of what is known about the molecular genetic basis of autosomal dominant retinitis pigmentosa. An attractive diagram illustrates 27 known deletions or substitutions of the heptahelical rhodopsin molecule, and the text discusses the different ways in which these genetic errors might alter the synthesis, transport, or function of the molecule.

Visual pigments and inherited variation in human vision. J NATHANS, C-H SUNG, C J WEITZ, C N DAVENPORT, S L MERBS and Y WANG. In: Sensory Transduction, D P Corey and S D Roper (eds), pp 110-131, Rockefeller University Press, New York, 1992.

A clear and very up-to-date review of the genetic alterations underlying red-green colour blindness, tritanopia, blue cone monochromacy, and the autosomal dominant forms of retinitis pigmentosa - written with the authority of the acknowledged master of the field. In very recent work, Dr Nathans and his collaborators have used a kidney cell tissue-culture system to express the mutant forms of the rhodopsin gene that are clinically associated with retinitis pigmentosa: a minority of the mutant forms of the protein molecule combine with 11-cis retinal, reach the cell membrane, and exhibit a normal absorption curve; but the majority are transported inefficiently to the plasma membrane and remain partially or predominantly in the endoplasmic reticulum, perhaps because they are incorrectly folded.

Covert processing in different visual recognition systems. G W HUMPHREYS, T TROSCIANKO, M J RIDDOCK, M BOUCART, N DONNELLY and G F A HARDING. In: The neuropsychology of consciousness (Eds. A D Milner, M D Rugg), Academic Press, London, 1992.

In this chapter is given the first detailed account of the dyschromatopsia of the much-studied object-agnosic patient HJA, earlier described by Riddock and her collaborators. The patient suffered bilateral damage to the occipital cortex as a result of a stroke. Although the patient describes his world as black and white and exhibits a high error score on the 100-hue test, he is not behaviourally achromatopsic. He reads many of the Ishihara plates and scores above chance on colour-naming and colour-matching tasks (chromaticities not given), though he makes many errors (the more so when the lightness of the stimuli is varied) and cannot judge the accuracy of his responses.

Author's Abstracts

Correlation of chromatic, spatial, and temporal sensitivity in optic nerve disease. S S GRIGSBY, A J VINGRYS, S C BENES and P E KING-SMITH. Invest Ophthalmol Vis Sci, 32: 3252-3262, 1991.

Spearman rank-order correlations (R) were made between the color-mixture threshold, spatial contrast sensitivity, and flicker sensitivity measurements of 38 patients with a variety of optic nerve

disorders. Patients had to satisfy the following criteria: >0.5 log unit loss of chromatic or achromatic sensitivity (compared to age-matched normals), central fixation, no congenital color defects, and no ocular media abnormalities. The results of the analysis show a significant correlation between selective losses of high spatial frequency sensitivity (relative to low) and selective losses of red/green and blue/yellow sensitivities [R = -0.680 (P<0.001) and R = -0.439 (P<0.01), respectively]. A mild correlation was found between selective spatial and selective temporal losses [r = -0.399 (P<0.05)] (ie, low temporal frequency losses correlate with high spatial frequency losses and vice versa). A stronger correlation was found between selective red/green and selective blue/yellow sensitivity losses [R = 0.657 (P<0.001)]. No correlation was found between selective temporal losses and selective chromatic losses. These findings can be explained in terms of differential losses of three types of fibers: (1) fibers that are particularly sensitive to red/green color, high spatial and low temporal frequencies; (2) fibers signalling blue/yellow color; and (3) fibers that are relatively sensitive to high temporal frequencies and low spatial frequencies - The Authors.

Aging of the human retina. Differential loss of neurons and retinal pigment epithelial cells. H GAO and J G HOLLYFIELD. Invest Ophthalmol Vis Sci, 33: 1-17, 1992.

The impact of aging on cell loss in the human retina was examined in foveal and temporal equatorial regions in eyes from 35 donors with ages spanning a 78-yr period from the second to the ninth decade of life. Equatorial cones and retinal pigment epithelial cells (RPE) decreased at uniform rates from the second to the ninth decade, 16 and 14 cells/mm^2/yr, respectively. Equatorial rods and cells in the ganglion cell layer (GCL) showed nonuniform rate decreases with age. The rates of rod and GCL cell loss were faster between the second and fourth decades (970 and 9 cells/mm^2/yr, respectively) than between the fourth and ninth decades (570-330 and 6-3 cells/mm^2/yr). The rod and GCL cell densities at the temporal equator maintained a constant ratio (rods-GCL cell ratio = 103 ± 0.4, mean ± standard deviation) and the same reduction slope ratio at different times during aging. Thus, the equatorial rod and GCL cell losses were correlated statistically. The ratio of equatorial photoreceptors to RPE cells showed no significant change with age, suggesting parallel loss of these closely apposed cells. At the foveal center, the variability of cone density between individuals in each decade grouping was large (1.7 - to threefold). No significant differences were found in cone or RPE cell densities at the foveal center from the second to ninth decade, suggesting that the densities of foveal cones and RPE cells were stable throughout this period. Foveal RPE density was significantly higher than equatorial RPE density in each age group. No significant difference was found between the equatorial photoreceptor-RPE density in each age group. Cells in the GCL in the fovea decreased by approximately 16% from the second to the sixth decade. These results indicated that (1) rod photoreceptors and cells in the GCL were more vulnerable to loss during aging than cones; (2) photoreceptors and RPE cells showed parallel changes during aging; and (3) the photoreceptor loss accompanying aging was less pronounced in the fovea than in the peripheral retina - The Authors.

Corneal autofluorescence: An indicator of diabetic retinopathy. T R STOLWIJK, J A VAN BEST, J A OOSTERHUIS and W SWART. Invest Ophthalmol Vis Sci, 33, 92-97, 1992.

The metabolic disorder in diabetics often results in progressive retinopathy with severe visual impairment. Changes in metabolism can influence corneal autofluorescence. This has led to speculation that diabetic retinopathy might be associated with changes in corneal autofluorescence. Corneal autofluorescence of both eyes was determined by fluorophotometry in 94 insulin-dependent diabetes mellitus patients and in 46 healthy controls to evaluate its correlation with diabetic retinopathy. The modified Airlie House classification was used for grading diabetic retinopathy: (1) no or negligible retinopathy; (2) minimal background retinopathy; (3) background retinopathy; and (4) (pre-) proliferative retinopathy. The corneal autofluorescence values of grade 1 retinopathy patients did not differ significantly from those of the healthy controls (mean ± standard deviation in ng equivalent fluorescein/ml: 11.6 ± 3.0 and 11.4 ± 2.8, respectively; P = 0.8). The means of grade 2, 3 and 4 retinopathy patients (mean ± standard deviation in ngEq fluorescein/ml: 16.2 ± 4.4, 16.7 ± 4.3, 20.9 ± 5.4, respectively) were significantly higher than the means of grade 1 patients and healthy controls (P<0.004). The mean values of patients with grade 4 were significantly higher than those of patients with grades 2 and 3 (P<0.01). The sensitivity and specificity of corneal autofluorescence as a screening test for diabetic retinopathy were 80% and 76%, respectively; the positive predictive value for the presence of retinopathy was 90%. The values for screening on (pre-) proliferative diabetic retinopathy were 68%, 72%, and 58%, respectively. These data show corneal autofluorescence to be an adequate indicator of diabetic retinopathy. This noninvasive technique, requiring less than one minute, can be applied efficiently as a clinical diagnostic tool for retinopathy screening in diabetic patients - The Authors.

Interocular differences in macular pigment density. B R HAMMOND and K FULD. Invest Ophthalmol Vis Sci, 33: 350-355, 1992.

Interocular differences in the optical density of macular pigment were examined. Foveal and parafoveal sensitivities to lights of 460 and 530 nm were measured by heterochromatic flicker photometry for both eyes of ten subjects. These two wavelengths represent the maximum and minimum absorbance for macular pigment. Taking the difference in log sensitivity to the 460 nm light for the fovea and parafovea, after normalizing with respect to 530 nm, yields a measurement of the optical density of the macular pigment. Consistent interocular differences in macular pigment density were found for only two subjects, and these differences were less than 0.1. Other subjects frequently showed significant interocular differences on a given day but showed no consistent differences over the course of many days. In general, the amount of macular pigment measured for one eye was found to be essentially the same as that for the other eye. When measurements were averaged for the two eyes of each subject, significant differences in macular pigment density among subjects were found - The Authors.

In situ measurements of lens fluorescence and its interference with visual function. J A ZUCLICH, R D GLICKMAN and A R MENENDEZ. Invest Ophthalmol Vis Sci, 33: 410-415, 1992.

Irradiation of the primate lens by near-ultraviolet wavelengths results in a blue fluorescence, which can be an intraocular source of veiling glare. This study quantitated the fluorescence intensity as a function of exciting intensity and wavelength. As the exciting wavelength was increased from 360 to 430 nm, the decreasing fluorescence intensity (for equal radiant exposures) was partially offset by a shift in the fluorescence spectrum to wavelengths of greater luminous efficiency so the luminance of the lens fluorescence remained approximately constant. The measured luminance of the lens fluorescence was high enough to imply degradation of visual function as a result of reduced contrast of the retinal image. To obtain an objective measure of visual deficit associated with the fluorescent glare, the visual evoked potential (VEP) elicited by counterphased sine-wave gratings was recorded while the subject eye was continuously exposed to the 413 nm emission from a krypton laser. The VEP amplitude was reduced in the presence of the exciting laser even at levels defined as "safe" (ie, where exposure levels are insufficient to induce an acute ocular lesion). Because the direct glare effect of the exciting radiation was negligible in this experiment, the VEP response loss is attributed to the effect of the lens fluorescent glare - The Authors.

Visual evoked potentials after photostress in patients with primary open-angle glaucoma and ocular hypertension. V PARISI and M G BUCCI. Invest Ophthalmol Vis Sci, 33: 436-442, 1992.

Visual evoked potentials (VEPs) were assessed in basal condition and after photostress in normal subjects, in subjects with ocular hypertension (OHT), and in subjects with primary open angle glaucoma (POAG). The VEPs recorded in base condition showed that in patients with OHT and POAG a latency of the P100 peak was higher than in controls. The amplitudes were reduced in POAG patients but not in OHT patients. In all eyes, the VEPs recorded 20 s after photostress showed an increase in latency and a decrease in amplitude. In the control eyes, the functional recovery was complete after 80 s. In the eyes with OHP and in the eyes with POAG, the parameter of VEP after photostress underwent greater changes than in the control eyes. VEPs were superimposable on the basal condition (recovery time) at 73.2 s in OHT patients and at 113.2 s in POAG patients. The longer VEP recovery time after photostress observed in OHT and POAG patients could be attributed to the reduced functionality of the outer layers or the inner retinal layers of the central retina, or both. This test may be useful in the clinical evaluation for early diagnosis of glaucoma - The Authors.

The distribution of macular pigment in human albinos. R V ABADI and M J COX. Invest Ophthalmol Vis Sci, 33: 494-497, 1992.

This study investigated the variation in density of macular pigment across the central retina in normal and albino subjects. Luminance profiles were measured using a fundus camera and digital video techniques. The normal group had pigment spatial distributions consistent with previous studies. The albinos had no variation in absorbance across the central retina - The Authors.

Supernormal cone electroretinograms in central retinal vein occlusion. P GOURAS and C J MACKAY. Invest Ophthalmol Vis Sci, 33: 508-515, 1992.

In 12 successive cases of unilateral central retinal vein occlusion (CRVO), the strongly light-adapted cone electroretinogram (both a- and b-wave) was always slower and larger (supernormal) to

long-wave stimuli compared with that of the unaffected eye. This supernormality became less as the level of light adaptation decreased; in the dark-adapted state, long-wave stimuli produced subnormal responses from the affected eye in all but two subjects. This supernormality was not caused by ineffectiveness of the adapting light related to a reduced cone quantal catch because it occurred in the dark. At any one state of adaptation, the supernormality increased with the wavelength of stimulation, paralleling the relative absorption ratio of long-middle wavelength-sensitive cones. This suggests that cones, especially long wavelength-sensitive cones, are less able to reduce their responsiveness to light with increasing levels of light adaptation in a retina affected by CRVO - The Authors.

Le Chroma Test. P LANTHONY. Bull Soc Opht France, 11: XCI, 999-1002, 1991.

The chroma test is a color vision test intended for the study of the saturation differential sensitivity. It includes two boxes : a so-called red-green box, including 20 caps, from red-purple to green (from 5 RP to 10 G Munsell), and a so-called blue-yellow (from 10 PB to 5 GY Munsell). In each box, the saturation caps (Chroma Munsell) vary in a decreasing, then in an increasing way, from a central grey cap (N 6 Munsell). The examining procedure is quite analogous to a well-known procedure used in another classification test : classification of the caps in a progressive order, from a reference cap. The results are expressed by a diagram and by scores for each box. The Chroma test was applied to 165 subjects. 111 were normal subjects, from 10 to 76 years, for the assessment of the norms of the test, the scores were normal if below 10, or equal to 10, for each of two boxes, the influence of age seems minimal. 56 were pathological subjects, with congenital or acquired dyschromatopsia of various etiologies ; the Chroma test was indicative of the predominant axis of the dyschromatopsia, by comparison between the results of the two boxes and, on the other hand, the Chroma test was pathological even in mild color vision deficiencies, being then of interest for the early diagnosis of diseases of the visual apparatus - The Author.

Les ombres colorées. P LANTHONY. Points de Vue, 28: 12-19, 1992.

The phenomenon of colored shadows occurs when an object is illuminated by two light sources of different colors. In this case two shadows appear, of complementary colors. The mechanism of coloring these shadows has been a matter for discussion ever since the times of Leonardo da Vinci and the first purely physical interpretation of the phenomenon (the color of the air, reflection from the sky) has evolved towards a more physiological explanation. Colored shadows are more than anything a phenomenon of simultaneous contrasts between colors, first made known by Count Rumford, and continued by the work of Goethe, Chevreul and the great German psychophysicians in the 19th century. The application of the colored shadows phenomenon to painting was applied by the Impressionists who used it to render the subtle realities of light on the canvases. Their successors, the Neo-Impressionists and Fauve brought it to a higher level of understanding, terminating paradoxically, with the abstract painting of Kandinsky - The Author.

Dichromats detect colour-camouflaged objects that are not detected by trichromats. M J MORGAN, A ADAM and J D MOLLON. Proc R Soc Lond B, 248: 291-295, 1992.

To explain the surprisingly high frequency of congenital red-green colour blindness, the suggestion has been made that dichromats might be at an advantage in breaking certain kinds of colour camouflage. We have compared the performance of dichromats and normal observers in a task in which texture is camouflaged by colour. The texture elements in a target area differed in either orientation or size from the background elements. In one condition, the texture elements were all of the same colour; in the camouflage condition they were randomly coloured red or green. For trichromats, it proved to be more difficult to detect the target region in the camouflage condition, even though colour was completely irrelevant to the task. Dichromats ($n = 7$) did not show this effect, and indeed performed better than trichromats in the camouflage condition. We conclude that colour can interfere with segregation based upon texture, and that dichromats are less susceptible to such interference - The Authors.

A reduction in stimulus duration can improve wavelength discriminations mediated by short-wave cones. J D MOLLON, S ASTELL and C R CAVONIUS. Vision Res, 32 (4): 745-755, 1992.

Virtually all visual discriminations become less accurate when either the luminance or the duration of the stimulus is reduced. An exception is found for wavelength discriminations near 460 nm, where an increase in either luminance or duration can cause the threshold to rise. For flashes of 100 msec or less, the critical variable is the total energy of the flash (i.e. the product of retinal illuminance and flash

duration), and wavelength discrimination is optimal at an intermediate value; higher stimulus energy causes discrimination to deteriorate. To explain these findings we suppose that discrimination in this region of the spectrum is mediated by a channel that draws opposed signals from the short-wavelength cones and from some combination of the middle- and long-wavelength cones, and that high stimulus energies cause saturation of this channel - The Authors.

The relationship between cone pigments and behavioural sensitivity in a New World Monkey (*Callithrix jacchus jacchus*). M J TOVÉE, J K BOWMAKER and J D MOLLON. Vision Res, 32 (5): 867-878, 1992.

Microspectrophotometric measurements of visual pigments and behavioural measurements of spectral sensitivity are reported for individual marmosets from 3 family groups. The sex differences and polymorphism that characterise the long-wave cone pigments in this species are well reflected by variations in the behavioural sensitivities. With one exception, the pattern of inheritance is compatible with a genetic model in which the long-wave pigment is specified by a single polymorphic locus on the X-chromosome. Measurements are also reported for the spectral absorbance of the marmoset lens, and these are used to reconstruct shot-wave behavioural sensitivity from the microspectrophotometric measurements of the short-wave cones - The Authors.

The polymorphic photopigments of the marmoset: spectral tuning and genetic basis. A J WILLIAMS, D M HUNT, J K BOWMAKER and J D MOLLON. The EMBO Journal, 11 (6): 2039-2045, 1992.

The marmoset (Callithrix jacchus jacchus), a South American monkey, is polymorphic for the middle- to long-wave cone photopigments: the three variant pigments have spectral peaks at 543, 556 and 563 nm. Comparisons of the deduced amino acid sequences of these pigments indicate that the variations in spectral sensitivity are associated with the presence or absence of hydroxyl-bearing residues at sites 180 and 285; but, in contrast to the additive hypothesis of Neitz et al. (1991), we propose that adjustments at site 233 may also be required to produce viable long-wave and middle-wave pigments. Within a family group of monkeys, we find that a restriction site polymorphism in the photopigment gene segregates in a way that is consistent with the single X-linked gene hypothesis previously proposed on the basis of the photopigment types present in male and female marmosets - The Authors.

Characterization of the electroretinographic scotopic B-wave amplitude in diabetic and normal subjects. E B ROECKER, E PULOS, G H BRESNICK and M SEVERNS. Invest Ophthalmol Vis Sci, 33: 1575-1583, 1992.

The intensity-response function of the scotopic b-wave of the electroretinogram may be a useful device for monitoring patients with retinal disease. Three models were evaluated that describe this function in 152 patients with diabetic retinopathy of varying severity and in 40 nondiabetic comparison subjects. The models considered were the Naka-Rushton equation fit to all 21 data points collected, the Naka-Rushton equation fit to the data points below the "second limb" of the function, and a log-linear fit only to data at the nine lowest intensities. In addition, the b-wave amplitude at each intensity tested was evaluated individually. Model parameters and amplitude measurements were compared with respect to (1) their ability to distinguish diabetic from nondiabetic subjects determined from the area under the receiver operating characteristic curve and (2) their correlation with retinopathic severity, graded in a standard fashion in fundus photographs. When all the parameters of each model were used in combination, there were no significant differences among the models with either evaluation criterion. Furthermore, b-wave amplitudes at midrange intensities (near -2.2 log cd-sec/m^2) did approximately as well as any model - The Authors.

Abnormal dark adaptation and rhodopsin kinetics in Sorsby's fundus dystrophy. R L STEINMETZ, P C POLKINGHORNE, F W FITZKE, C M KEMP and A C BIRD. Invest Ophthalmol Vis Sci, 33: 1633-1636, 1992.

Scotopic visual thresholds and time courses for dark adaptation were determined in eight patients with Sorsby's fundus dystrophy. Rhodopsin regeneration also was recorded in two. All patients had poor night vision and a visible yellow deposit at the level of Bruch's membrane that was confluent in the posterior pole. In retinal regions with the yellow deposit, scotopic thresholds were elevated, the rod-cone break was delayed or indistinct, the time courses for the rod portion of the dark adaptation curve was prolonged, and rhodopsin regeneration was slow in the one patient in whom measurements were made. In regions of ophthalmoscopically normal retina, dark adaptation was affected minimally, and in one patient, rhodopsin was regenerated at a normal rate. It was

hypothesized that the abnormal dark adaptation and rhodopsin kinetics might be caused by reduced metabolic exchange across a thickened Bruch's membrane - The Authors.

Contrast thresholds for letter identification in retinitis pigmentosa. K R ALEXANDER, D J DERLACKI and G A FISHMAN. Invest Ophthalmol Vis Sci, 33: 1846-1852, 1992.

To assess mechanisms of foveal vision loss in retinitis pigmentosa (RP), contrast thresholds were measured for the identification of Sloan letters at four adapting field luminances (0.4, 1.4, 2.4 and 3.4 log td) in a group of 16 patients with RP who had best-corrected Snellen visual acuities of 20/30 or better, minimal or no posterior subcapsular cataracts, and no atrophic or cystic-appearing foveal lesions. Letter contrast sensitivities of the patients with RP were reduced below those of a group of ten subjects with normal vision for all letter sizes and at all adapting field luminances. The overall pattern of these results indicated that neither a reduced quantal absorption by foveal cones nor spatial under sampling from a loss of foveal cones accounted for the reductions in letter contrast sensitivities. The findings were most consistent with a uniform increase in intercone spacing in the foveas of this group of patients with RP and mild visual acuity loss - The Authors.

Ophthalmoscopy versus fundus photographs for detecting and grading diabetic retinopathy. J L KINYOUN, D C MARTIN, W Y FUJIMOTO and D L LEONETTI. Invest Ophthalmol Vis Sci, 33: 1888-1893, 1992.

Reported here is the agreement between three examination methods chosen to detect and grade diabetic retinopathy in 124 subjects with type II (noninsulin-dependent) diabetes mellitus. These three examination methods include ophthalmoscopy (indirect and direct) by a retina specialist, seven standard field fundus photographs read by the same retina specialist, and the same photographs read by a trained photographic grader at the Fundus Photograph Reading Center. For the 59 subjects examined with all three methods, these results indicated fair to good (kappas, 0.69-0.84) agreement between the retina specialist's and trained grader's reading of photographs, fair to good (kappas, 0.58-0.79) agreement between the retina specialist's ophthalmoscopic findings and the specialist's reading of photographs, and fair (kappas, 0.49-0.62) agreement between the retina specialist's ophthalmoscopic findings and the trained grader's reading of fundus photographs. Analysis of the disagreements confirmed earlier reports that ophthalmoscopy misses approximately 50% of eyes with microaneurysms only. Other disagreements resulted from the trained grader's overreading photographs of eyes with lesions simulating diabetic retinopathy. Of the 393 total subjects (diabetic and nondiabetic) in this study, such lesions were seen with ophthalmoscopy in six eyes of six subjects (2.4% of diabetic patients and 1.1% of nondiabetic subjects). The authors believe at least one definite retinal microaneurysm should be present in one eye before establishing the diagnosis of diabetic retinopathy in diabetic patients - The Authors.

Progressive color visual field loss in glaucoma. P A SAMPLE and R N WEINREB. Invest Ophthalmol Vis Sci, 33: 2068-2071, 1992.

Twenty one eyes with primary open angle glaucoma were tested with standard (white stimulus-on-white background) and color (blue stimulus-on-yellow background) visual fields over a range of 6-26 mo. There was no significant increase in threshold between the initial and final standard fields overall or by quadrant ($P < 0.188$, overall field). A significant increase in mean log thresholds for all areas of the color visual field ($P < 0.019$, overall field) was found. Of the 21 patients, nine worsened by > 0.2 log units, two improved by > 0.2 log units, 7 worsened by < 0.2 log units, and three improved by < 0.2 log units. When these same patients were matched to 21 normal eyes by age, lens density, and acuity they showed significantly reduced thresholds throughout their color visual fields ($P < 0.023$). Whereas normal age-related increases in threshold for the short-wavelength system are only 0.10 log units per decade ($n = 88$), 10 glaucomatous eyes with increases of 0.14-0.75 log units were found within only 26 mo. The authors conclude that color visual fields may indicate significant change in visual function before it is apparent on standard visual fields - The Authors.