DALTONIANA

NEWSLETTER
OF THE INTERNATIONAL RESEARCH GROUP ON COLOUR VISION DEFICIENCIES

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February 1992 No.74

IRGCVD News

1993 IRGCVD Symposium

The 12th Symposium of the IRGCVD will take place in Tübingen, Germany during the last two weeks of July. Our invited speakers are Professor Marion Marré, who will also be the Verriest Lecturer, Professor Senir Zeki and Professor Eberhart Zrenner. Their keynote lectures will introduce the special topics of the Symposium: respectively "Scotopization", "Anatomy of Colour Vision" and the "Blue Cone Mechanism".

This issue includes an account of the 11th Symposium in Sydney by Anthony B Morland (not related to the Editor!) who was one of the young researchers awarded an IRGCVD travel grant to attend. The first such account by Dr Tsaiyao Yeh was published in Daltoniana No 73. These accounts by our young members highlight issues which capture their attention and imagination (or which they think we think should do so!)

Report on IRGCVD-AIC Meeting

The IRGCVD symposium in Sydney, Australia gave me my first opportunity to present a paper to an international conference. I was also able to put faces to many of those authors whose papers I had read in the course of my studies. The social functions, so well organised by Stephen Dain and his wife, were an excellent complement to the conference timetable. Those functions allowed me to get to know many workers from Australia, Japan, and the USA. A similar event anywhere else would not, I suspect, have produced such global representation. In all, Australia was the perfect venue, and the Australians made excellent hosts.

Of the many well presented papers given at the meeting, I will mention those of particular interest to me. In the session devoted to Genetics and Congenital Deficiencies, Samir Deeb and his colleagues, in their paper entitled Molecular Studies on Genotype - Phenotype Relationships in Human X-linked Red/Green Colour Defects, found that trichromacy and dichromacy could not always be predicted from molecular patterns. Jennifer Birch, in the same session, presented a paper on the Rayleigh matches of 127 anomalous trichromats, and found that matching ranges were distributed continuously. She emphasized that theories derived from molecular genetics must be able to account for such variations. The papers described above gave a good overview of the current advances in molecular genetics and also the requirements that results of psychophysical measurements place on any theory of congenital colour vision deficiencies, and in particular anomalous trichromacy. Psychophysical methods, by which the absorption characteristics of anomalous pigments are derived, have shown little success, but clearly the absorption spectra are the key to formulating any theory of anomalous trichromacy. Spatial aspects of colour vision were dealt with in a subsequent session, initiated by an interesting review lecture by Harry Sperling. This was followed by by a paper in which Cole, Hine and Scott demonstrated that the illusory Craik-Cornsweet effect was observed for luminance, but not colour contours. A poster presented by Patrick Flanagan indicated that mechanisms responding to equiluminant colour gratings were orientation selective. The relation between spatial form and colour are extremely important in understanding human visual processing hierarchy and segregation, and studies described above in conjunction with anatomical studies are of great value.

Perhaps the highlight of the meeting, was the invited paper by Barry Cole entitled "Does Defective Colour Vision Really Matter?". The lecture detailed some well documented case studies of colour defective subjects working in jobs requiring the passing of certain colour vision tests. One such case of a British sailor emphasized how an observer may be capable of passing a specific colour vision test and yet may exhibit an undesirable colour vision defect. An account of a recent Australian legal case, in which an airline pilot with defective colour vision was considered suitable for his chosen occupation, was given. This

example illustrated the influence of those who advocate equal employment opportunities for employees with colour vision defects, and the consequent result of their actions. As I heard Jennifer Birch say, some time later, it was a relief to be flying with the World's favourite airline. The conclusion of Barry Cole's lecture was the proposal of a scheme of colour vision testing which included a number of the widely accepted tests. This approach and an international acceptance of colour vision standards required for specific vocations are, as Barry Cole indicated, necessary in order that certain jobs are filled by people who are not at risk of being unable to perform the tasks involved in that job.

I would like to thank the IRGCVD for their generous financial assistance which enabled me to attend what I considered to be a most valuable conference.

A B Morland

Literature Survey

Authors' Abstracts

Entoptic visualization of the retinal vasculature near fixation. R A APPLEGATE, A BRADLEY and W A J VAN HEUVEN. Invest Ophthalmol Vis Sci, 1990, 31, 2088-2098

The authors review (1) the range of techniques used to study the retinal vasculature near the fovea, (2) describe the need and rationale for noninvasive in vivo monitoring of the retinal vasculature, (3) present theoretic and practical considerations which show that entoptic visualization of the smallest capillaries near the fovea is optimized by a small short-wavelength source (1 mm or less) rotating at 3.5 hertz in a circular path (radius 2 mm) imaged in the plane of the eye's entrance pupil, and (4) discuss the feasibility of using these techniques as a research and clinical tool.

Retinal fixation point location in the foveal avascular zone. B S ZEFFREN, R A APPLEGATE, A BRADLEY and W A J VAN HEUVEN. Invest Ophthalmol Vis Sci, 1990, 31, 2099-2105.

The site of normal fixation is often assumed to be centered in the foveal avascular zone (FAZ). This assumed anatomic relationship is used during photocoagulation therapy as an objective guide to avoid damaging critical retinal structures on or near fixation. With laser therapy being directed closer and closer to the center of the FAZ, the accuracy with which the center of the FAZ locates the retinal point of fixation becomes an important therapeutic issue. Using an optimized technique for visualizing the retinal vasculature entoptically, the authors determined the location of the retinal point of fixation with respect to the foveal area vasculature in 26 eyes of 14 healthy subjects. In 23 eyes (12 subjects), a traditional FAZ was observed, the other three eyes (two subjects) had capillaries near or crossing the center of fixation. Of the 23 eyes with a traditional FAZ, 20 had centers of fixation located eccentric to the center but in the FAZ, (average deviation from the center of the FAZ, 66.5 $\pm$ 49.5 μm) with the direction of deviation from the FAZ center appearing random. Consequently, when following protocols that advocate photocoagulation treatment with spot centers closer to the FAZ center than 300 μm, the center of the FAZ is a poor locator of a subject's retinal point of fixation. When using the FAZ as a reference, the resulting uncertainty in the location of the subject's retinal point of fixation increases the probability of significant damage to the actual point of fixation by up to 20%.

Fixation characteristics in macular disease. Relationship between saccadic frequency, sequencing, and reading rate. T T McMAHON, M HANSEN and M VIANA. Invest Ophthalmol Vis Sci, 1991, 32, 567-574.

The relationship between reading rate and saccadic frequency in patients with macular degeneration was studied to determine if this simple measure of eye movements would be helpful in explaining the reduction in reading rates. Nineteen subjects and five controls were tested for visual acuity, reading rate, and saccadic frequency for intended stationary, simple left-to-right, and swquencing step tasks. Eye movements were recorded using an electro-oculography technique. Absolute eye position was not known. The results deomonstrated that, using a 2 threshold for a stationary target, patients refixated a mean of 42.7 times per min, and controls refixated 0.00 times per min. For a two-letter left-to-right task, patients averaged 3.57 times more saccades than an ideal response, and controls had 1.14 times more saccades than ideal ($P < 0.01$). For a five-letter left-to-right sequencing task, patients refixated a mean of 2.10 times more than ideal, and controls refixated 1.15 times more than ideal ($P < 0.05$). Regression analysis demonstrated that sequencing task scores of saccadic frequency and visual acuity were the best predictors of reading rate ($r^2 = 0.705$). These results indicate that higher saccadic frequencies are associated with lower reading rates and that there appears to be a relationshio between the sequencing of visual information and reading rate.

Biological control of primate macular pigment. Biochemical and densitometric studies. G J HANDELMAN, D M SNODDERLY, N I KRINSKY, M D RUSSETT and A J ADLER. Invest Ophthalmol Vis Sci, 1991, 32, 257-267.

The amounts of zeaxanthin (Z) and lutein (L), the carotenoids constituting the primate macular pigment, were measured in the central retinas of monkeys (Saimiri sciureus and Macaca fascicularis). Two independent methods - reverse-phase high-performance liquid chromatography (HPLC) and microdensitometry - were used for analysis of the same set of retinas. Most of the measurements were made on retinas that had been fixed by glutaraldehyde-paraformaldehyde perfusion of the animal. Control experiments showed that this fixation did not interfere with the quantitative extraction and analysis of the carotenoids. The amount of macular pigment calculated from microdensitometry of the foveal region was proportional to the amount of pigment assayed by HPLC of the same retinal area, demonstrating that either method can be used reliably to rank the carotenoid content of aldehyde-fixed foveas. The optical density of pigment in the axial direction through the retina was higher than would be predicted if the pigment were randomly oriented. This is consistent with the idea that the nonrandom orientation of the dichroic macular pigment molecules found in previous studies contributes to increased optical filtering of the retinal image. Comparisons of the amounts of Z and L between the left and right eyes of the same monkey, within 1 mm of the foveal center, always showed excellent agreement (averaging a 5% difference for Z and 11% difference for L), whereas differences among individual monkeys were very large (up to fourfold for Z). These results indicate that the uptake and assimilation of the macular carotenoids are biologically regulated by selective mechanisms in primate retinas.

Distribution of individual macular pigment carotenoids in central retina of macaque and squirrel monkeys. D M SNODDERLY, G J HANDELMAN and A J ADLER. Invest Ophthalmol Vis Sci, 1991, 32, 268-279.

The spatial distribution of lutein (L) and zeaxanthin (Z), the structural isomers composing the macular pigment, was studied in the retinas of macaque monkeys (Macaca fascicularis) and squirrel monkeys (Saimiri sclureus). Spatial profiles of macular pigment optical density were obtained from retinal whole mounts. Then concentric annuli were microdissected from the fovea and adjacent regions of the same retinas. Each retinal segment was analyzed for carotenoids by high-performance liquid chromatography. Both L and Z reached their highest concentrations at the center of the fovea and declined monotonically with eccentricity for both primate species. This is inconsistent with a preferential association of L with rods. Macaque monkeys have a consistent pattern of more Z than L at the foveal center, like humans. Z declines more rapidly than L with eccentricity, so that L becomes dominant in the periphery. Squirrel monkeys (all male) showed striking individual differences. Some had more Z than L at the foveal center like macaques, but four of six had the reverse pattern, with more L than Z throughout the central retina. Individual differences among squirrel monkeys may be linked to their color vision polymorphisms. This suggests that a particular Z/L ratio in primate retinas may be associated with a specific cone phenotype, just as particular carotenoids are associated with specific cone types in vertebrates with cone oil droplets.

Spectrophotometric quantitation of rhodopsin in the human retina. F J G M VAN KUIJK, J W LEWIS, P BUCK, K R PARKER and D S KLIGER. Invest Ophthalmol Vis Sci, 1991, 32, 1962-1967.

The rhodopsin content of the human retina was determined spectrophotometrically. Retinas were removed completely by using an **in vitro** *technique based on a simulation of retinal detachment. This method provides a total recovery of rod outer segments which contain the rhodopsin visual pigment or its apoprotein, opsin. Using this improved dissection method followed by a crude preparation of the retina, an opsin-rhodopsin content of 6.20 0.64 nmol/retina (n = 9) was found. This is larger than values previously reported. Regeneration with a threefold excess of 11-cis-retinal improved the recovery of rhodopsin dramatically because the corneas of these human donor eyes were removed for corneal transplant surgery under relatively bright light that bleaches the retina nearly completely. The amount of rhodopsin that can be isolated will be sufficient for studies on early events in visual transduction using laser photolysis.*

Maintenance of opsin density in photoreceptor outer segments of retinoid-deprived rats. M L KATZ, M J KUTRYB, M NORBERG, C-L GAO, R H WHITE and W S STARK. Invest Ophthalmol Vis Sci, 1991, 32, 1968-1980.

Dietary deficiency in the retinoid precursors of the visual pigment chromophore 11-cis-retinal eventually results in selective degeneration of the photoreceptor cells of the vertebrate retina. Early effects of retinoid deficiency are depletion of rhodopsin from the retina and vesiculation of the photoreceptor outer segment disc membranes. Experiments were conducted to determine whether these early changes were accompanied by an alteration of the opsin content of the disc membranes. After being fed a retinoid-deficient diet containing retinoic acid for 26 weeks, the rhodopsin content of rat retinas was

reduced by over 85%. Both the diameters and the lengths of the outer segments decreased significantly. However, immunocytochemical and freeze-fracture analyses indicated that retinoid deficiency did not lower opsin density in the outer-segment disc membranes. These findings indicate that in the rat, opsin synthesis and disc assembly are coordinated processes that remain coupled despite reduced availability of the vitamin A chromophore. The fact that disc size decreases and disc synthesis eventually ceases in retinoid-deprived rats indicates that specific retinoids are essential for disc morphogenesis. The mechanism by which these retinoids regulate disc assembly remains to be determined.

Rod densitometry in the aging human eye. A T A LIEM, J E E KEUNEN, D VAN NORREN, and J VAN DE KRAATS. Invest Ophthalmol Vis Sci, 1991, 32, 2676-2682.

Retinal densitometry is a noninvasive physiologic technique used to examine the visual pigments in living human eyes. To assess possible age-related disturbances of rod photopigment kinetics, retinal densitometry was done in 44 eyes of 44 healthy subjects (age range, 12-78 yr). With progressing age, a significant but small increase in photopigment density difference (bleached versus dark adapted eye) and an increase in the time constant of rhodopsin regeneration was found. The increased density difference in rods was consistent with morphologic findings of increased rod outer segment diameter and disc content in older subjects. To explain this change in terms of the decreased specular reflections at the level of the inner limiting membrane was inadequate because age effects were independent of wavelength in the region of 450-550 nm. To control for the effects of ocular stray light from the lens, subjects older than 40 yr with a clear crystalline lens were measured and compared with those with pseudophakia. No statistically significant difference was found between the two groups. Increased rod density difference contrasts sharply with an earlier reported decrease in this parameter for foveal cones. The slowing of the regeneration rate is a phenomenon common to rods and cones. It may be a result of a gradual metabolic dysfunction of the retinal pigment epithelium in older subjects.

Dyschromatopsias et art pictural (*Dyschromatopsias and pictorial art*). P LANTHONY. J Fr Ophtalmol, 1991, 14, 8-9, 510-519.

The influence of color vision defects on pictorial art was studied using three methods. 1) From a theoretical standpoint, the possibilities of choice of the color-blind painter are determined by the nature of his color perception. Characteristic errors result from the fact that he has to choose between many hues which are different to normal individual but which all look the same to him. 2) Evaluation of the clinical cases of painters with dyschromatopsias has shown evidence of the following: a) the color-blind painter makes mistakes according to the type of color defect; b) if the color-blind painter makes several copies of the same model, he makes different mistakes at each attempt; c) when several color-blind painters make copies of the same model, they also make different mistakes, even when they suffer from the same type of color vision defect. Preferences for some colored patterns were studied by means of a forced choice procedure and choices of color-blind individuals were often characteristic of their dyschromatopsia. Recent clinical cases of acquired dyschromatopsia reported in the literature are discussed, as is a personal case of a painter suffering from tapeto-retinal degeneration. This was a severe dyschromatopsia with a neutral zone in purple (so-called scotpic axis, by Verriest's terminology). The painting of this artist tended to be monochromatic, mainly in green and green-blue colors. 3) Recent studies in art history have shown that only the romantic etcher Meryon was definitely color deficient. The more dubious cases of the Polish painter Grottger and Eugène Carrière are discussed and conclusions are negative. Among acquired dyschromatopsias, there have been many recent papers devoted to cataract, concerning the cases of Rouault, Monet and Mary Cassatt. The hypothesis of a degree of chromatopsia of toxic origin in the case of Van Gogh is also assessed. In conclusion, the problem of the relations between congenital or acquired dyschromatopsias and pictorial art seems very complex and great care is required when making deductions and advancing hypotheses.

Analysis of normal flicker sensitivity and its variability in the Visuogram test. C W TYLER. Invest Ophthalmol Vis Sci, 1991, 32, 2552-2560.

Flicker sensitivity was measured in groups of younger and older adult observers to assess its mean values and the test-retest variability both between sessions and in a single session. Test-retest sensitivities differed by less than 15% but tended to decrease slightly in a session and increase slightly between sessions. Optical blur had little effect on the measured sensitivities, implying that they were not mediated by the edge information in the display. There were no significant differences between eyes other than those attributable to testing order. Within eyes, inherent variations in human flicker sensitivity accounted for about half of the variance, and within-session variability accounted for most of the remainder.

Rod visual fields in cone-rod degeneration. Comparisons to retinitis pigmentosa. D G BIRCH and J L ANDERSON. Invest Ophthalmol Vis Sci, 1990, 31, 2288-2299.

Dark-adapted visual fields to short- and long-wavelength stimuli were obtained from 20 patients with cone-rod degeneration, 20 patients with retinitis pigmentosa, and ten normal subjects. Patients were selected because they retained rod electroretinographic (ERG) function over a sufficient range for the Naka-Rushton analysis of retinal illuminance versus amplitude functions. Patients with cone-rod degeneration retained a relatively normal field topography although overall sensitivity was reduced. The mean sensitivity loss was consistent with a small elevation in ERG semisaturation constant and minimally delayed rod b-wave implicit times. Rod visual fields from patients with retinitis pigmentosa retaining rod ERG function were consistent with log sensitivity profiles reported previously for type 2 patients. Sensitivity loss was greatest in midperipheral regions, with most patients showing least loss in the far periphery. Disproportionate loss in the midperiphery is consistent with a large elevation in the ERG semisaturation constant and prolonged rod b-wave implicit times.

Acuity-luminance and foveal increment threshold functions in retinitis pigmentosa. K R ALEXANDER, D J DERLACKI, G A FISHMAN, and N S PEACHY. Invest Ophthalmol Vis Sci, 1991, 32, 1446-1454.

Acuity-luminance functions and foveal increment threshold functions were measured in 20 subjects with retinitis pigmentosa (RP) who had Snellen acuities of 20/40 or better, minimal or no posterior subcapsular cataracts, and no atrophic-appearing foveal lesions. Compared with the results from ten normal subjects, the visual acuities of the RP subjects were reduced at all luminance levels; the acuity deficits were more pronounced at low luminances. Foveal detection thresholds of the RP subjects showed the greatest elevation at low background luminances and approached normal values at high adapting levels. There was a statistically significant correlation ($r=0.79$, $P<0.01$) between the visual acuities and absolute thresholds of the RP subjects. The overall pattern of results cannot be explained by a reduced quantal absorption in foveal cones, but it is consistent with the hypothesis that a reduced cone spatial density is the primary mechanism of foveal visual loss in this group of RP subjects.

The influence of intraocular pressure on visual field damage in patients with normal-tension and high-tension glaucoma. B C CHAUHAN and S M DRANCE. Invest Ophthalmol Vis Sci, 1990, 31, 2367-2372.

There have been several reports to suggest that the type of visual field damage in open-angle glaucoma is influenced by intraocular pressure (IOP). This study was undertaken to determine the extent to which patients with normal-tension (NTG) and high-tension glaucoma (HTG) could be differentiated on the basis of some features of their visual fields. The results from 40 pairs of NTG and HTG patients were matched closely for the extent of visual field damage, pupil size, and visual acuity. Using this pooled material, the authors increased the IOP difference between the two groups in either direction, ie, by either progressively lowering the highest recorded IOP allowed for inclusion in the NTG group or by progressively increasing that required for inclusion in the HTG group. They compared the normal areas of the patients' visual fields by using simple visual field indices designed to quantify the undisturbed field. Using receiver operating characteristics (ROC) analysis, they showed that changing the inclusion criterion in the NTG group resulted in no better separation between the groups. However, when the inclusion criterion was changed in the HTG group, the two groups tended to become more separable. In this case, the degree of separation appeared to be related to the difference in the highest recorded IOP between the two groups although the separation was not complete. These findings show that pressure has a greater influence on the type of visual field damage at the higher end of the IOP spectrum encountered in open-angle glaucoma and suggest that there is no common single pathophysiologic mechanism in this disease.

A study of variance in densitometry of retinal nerve fiber layer photographs in normals and glaucoma suspects. R H EIKELBOOM, R L COOPER and C J BARRY. Invest Ophthalmol Vis Sci, 1990, 31, 2373-2383.

The main object of this research was to develop a reliable method of screening glaucoma suspects and patients for early loss of or changes in the retinal nerve fiber layer (RNFL). This study quantifies the variances due to photography, digitizing, and analysis of red-free photographs of the RNFL. The influence of pupil size, optic disc position and eye movements, film processing, digitizing, and intra- and interphotographic-session and intra- and interoperator variances were established. It was found that pupils needed to be dilated to at least 6mm, that the optic disc had to be positioned in a standardized area in the negative, that the head of the subject had to remain still during photography, and that film processing and digitizing of the negative needed to be strictly controlled to minimize the variance in collection of densitometry data from RNFL red-free photographs. It was established that focusing of the negatives during digitization was not crucial. Criteria were defined for acceptable negatives.

Interphotographic-session and intraoperator variances were not significant in most cases when negatives were digitized to these criteria. Analysis of interphotographic-session variance showed that there were still some factors in photography, film processing, and/or image digitizing that were not sufficiently controlled for long-term follow-up without normalization of the data. Densitometry data gathered using the established protocol, from negatives of 71 subjects were analyzed; best sensitivity and specificity rates of 80% and 100%, respectively, were achieved for the diagnosis of glaucoma.

Intraocular pressure-dependent light sensitivity in glaucoma. T KRAKAU, D MULLINS and M LANGHAM. Invest Ophthalmol Vis Sci, 1990 31, 2551-2559.

The intraocular pressure-dependent light sensitivity of discrete retinal points was measured using the Heijl-Krakau automated light-emitting diode perimeter with an appropriate software program. A total of 300 measurements of light sensitivity were recorded from six retinal points during the test period of 8-10 min; increased intraocular pressure was induced using a Langham scleral suction-cup system. The ocular pulsatile blood flow and the ophthalmic arterial pressure were measured in the same patients. The fluctuation of the light sensitivity was less than 5% over the test period in healthy eyes and remained unaffected by an intraocular-pressure increment of 20 mm Hg; a small decrease of sensitivity occurred at a pressure increment of 30 mm Hg. In glaucomatous eyes the light sensitivity was lower and the fluctuation of the light sensitivity at some but not all retinal points was substantially greater than in the controls. In the glaucomatous eyes, an intraocular-pressure increment of 20 mm Hg increased the fluctuation and decreased the light sensitivity. The pulsatile ocular blood flow was lower in the glaucomatous eyes but not severe enough to be solely responsible for the loss of vision. The coexistence of retinal points with normal and abnormal stabilities of light sensitivity in glaucomatous eyes as consistent with impaired blood flow in the lamina cribosa.

Peripheral color contrast. A new screening test for preglaucomatous visual loss. T C YU, F FALCAO-REIS, W SPILEERS, and G B ARDEN. Invest Ophthalmol Vis Sci, 1991, 32, 2779-2789.

A new test of peripheral color contrast is described. A high-definition color monitor driven by a personal computer with a graphics interface card displays an annulus subtending 25 at the eye. The color contrast between the annulus and the background can be varied. Forty-five degrees of the annulus is randomly removed in one of four quadrants. Patients are asked to identify the position of the gap while fixating a central spot. The minimum color contrast between annulus and background at which the identification is possible is between 13-16% for the protan, deuteran, and tritan axis in normal subjects. This threshold value changes little with age, refractive error, or pupillary aperture, and test-retest variability is low. Testing one eye takes only 1-2 min. The test was applied to ocular-hypertensive and glaucomatous patients. All patients with glaucoma had thresholds greater than two standard deviations (SD) above the normal mean. In addition, 97% of glaucoma patients had thresholds greater than four SDs, and 95% had thresholds more than five SDs above the normal mean. Most patients with ocular hypertension and clinical signs indicating a low or medium risk of conversion to glaucoma had thresholds under the upper limit of normal. High-risk patients with ocular hypertension fell into two groups. One approximated to normal; the other had elevated thresholds, which in many cases were more than four SDs above the normal mean. The epidemiologic consequences of this test are discussed.

Temporal contrast sensitivity loss in primary open-angle glaucoma and glaucoma suspects. M E BRETON, T W WILSON, R WILSON, G L SPAETH, and T KRUPIN. Invest Ophthalmol Vis Sci, 1991, 32, 2931-2941.

The need for more sensitive tests for the early detection of compromised visual function in glaucoma is established by anatomic and psychophysical evidence of damage occurring to optic nerve fibers in eyes with normal visual fields. The results are reported of temporal frequency testing on 51 glaucoma suspects without visual field loss in either eye, 52 glaucoma patients with visual field deficits in the tested eye, and 11 normal subjects. Modulation transfer functions were obtained using a sinusoidally flickering 5° spatially uniform white field viewed with central fixation and plotted at six frequencies from 5-30 Hz. The results showed a frequency-specific sensitivity loss centred at 15 Hz and a nonfrequency-specific mean sensitivity loss, that was greater, on average, in glaucoma patients than in suspects. Sensitivity losses of both kinds were seen in most glaucoma patients, but only in a minority of glaucoma suspects. About 12% of suspects were indistinguishable from the lowest performing one third of these glaucoma patients. A smaller number of suspects appeared to form a second mode in the frequency distribution for temporal sensitivity at 15 and 25 Hz. In patients with glaucoma, age was found to be a significant factor associated with the magnitude of mean sensitivity loss. Age was not a significant factor contributing to sensitivity loss in individual suspect data as measured by regression analysis, but it contributed to a small and consistent sensitivity loss across frequency for group-averaged data in those older than 55 years of age.

Relations between fundus appearance and function. Eyes whose fellow eye has exudative age-related macular degeneration. A EISNER, V D STOUMBOS, M L KLEIN, and S A FLEMING. Invest Ophthalmol Vis Sci, 1991, 32, 8-20.

Foveal visual function was compared with fundus appearance for 41 eyes that had good acuity but whose fellow eye had exudative age-related macular degeneration (AMD). The visual functions tested were among those reported to be compromised by AMD. They included: (1) dark adaptation, (2) absolute sensitivity, (3) S cone-mediated sensitivity, and (4) color matching. The fundus features used to evaluate the risk of developing exudative AMD included: (1) drusen confluence, (2) drusen size, and (3) focal hyperpigmentation. For the group of eyes defined by the presence of one or more high-risk fundus characteristics, all visual functions were compromised significantly. In particular, all 21 eyes with abnormally slow rates of dark adaptation had high-risk fundi, and all 16 eyes with abnormal color matching (ie, a small effect of test area on the color match or rejection of all potential color matches) had high-risk fundi. Conversely, 30 of the 32 eyes with high-risk fundi had abnormally slow rates of dark adaptation or abnormal color matching. In addition, reduced acuity in the fellow exudative eye was associated significantly with a high-risk fundus in the nonexudative eye.

Lenses of diabetic patients "yellow" at an accelerated rate similar to older normals. M LUTZE and G H BRESNICK. Invest Ophthalmol Vis Sci, 1991, 32, 194-199.

The authors used a psychophysical method to measure lens transmission of young, type I diabetic patients and normal controls. The results from normal controls agreed with previously published reports of decreasing lens transmission with age, and those from diabetic subjects suggested that lenses of young, type I diabetic patients age or "yellow" at an accelerated rate that was similar to that of normal controls over the age of 60 yr. The rate of accelerated lens density that occurs per year with the duration of diabetes is similar to the rate of accelerated lens density that occurs per year with patient age over 60 yr. A possible molecular explanation for the accelerated lens yellowing in both populations is discussed. Both diabetic individuals and the older normal populations have elevated plasma glucose levels and therefore may have accelerated glycosylation of lens proteins which causes increased lens yellowing.

Effect of instillation of aldose reductase inhibitor FR74366 on diabetic cataract. S AO, C KIKUCHI, T ONO, and Y NOTSU. Invest Ophthalmol Vis Sci, 1991, 32, 3078-3083.

The authors investigate the effect of aldose reductase inhibitor FR74366 on diabetic cataract. Streptozocin (STZ)-induced diabetic rats were treated with eye drops of FR74366 (0.03%, 0.1%, and 0.3%) for 16 weeks. Lenses were examined using a slit lamp, and the score of lens opacity was determined on a scale of from 0 (normal lens) to 4 (matured nuclear cataract). Diabetic placebo control rats developed lens opacity linearly, beginning at 3 weeks and reaching a maximum at 8 weeks after STZ injection. Instillation of FR74366 to diabetic rats delayed the cataract formation and inhibited lens sorbitol accumulation in a dose-dependent manner. At 16 weeks after STZ injection, the score of lens opacity was more than 3 (diffuse central opacities) in diabetic placebo control rats, whereas it was less than 2 (peripheral vesicles and cortical opacities) and the lenses remained clear in animals treated with 0.3% of FR74366. Measurement of tissue drug concentrations indicated that FR74366 penetrated into the lens, where its levels were increased in a dose- and time-dependent manner. These three parameters (score of lens opacity and sorbitol and FR74366 levels) were well correlated with each other. Instillation of FR74366 also reduced the sorbitol levels in the retina. However, the sorbitol levels in the sciatic nerve and renal cortex were not changed by instillation of FR74366. Instillation or oral administration of FR74366 has not shown serious side effects in animal toxicity studies. These results suggested that instillation of FR74366 may be a useful therapeutic agent against diabetic cataract and retinopathy.

A comparison of two photographic systems for grading cataract. H R TAYLOR, J A LEE, F WANG and B MUÑOZ. Invest Ophthalmol Vis Sci, 1991, 32, 529-532.

Two different systems for classifying lens opacities were compared: the Lens Opacity Classification System version II (LOCS II) and the system developed at Johns Hopkins University. Using the two systems, slit-lamp photographs of the nucleus and retroillumination lens photographs of 100 eyes were graded. Each photograph was graded independently by three trained observer, and the time taken to grade the photographs was similar. Each system uses photographs to define the severity of nuclear opacity and nuclear color, and each showed good interobserver agreement (kappa statistic, >0.6). The method of classifying cortical and posterior sucapsular opacity varied, and although interobserver agreement was acceptable in each system, it was somewhate higher with the Hopkins system. Because different standards and definitions are used to define severity with each system, there was some variation in the classification of individual photographs and corresponding differences in the proportion of photographs in each grade of severity. These data provide a useful cross reference for future comparison of studies using these systems.

The effect of cataract severity and morphology on the reliability of the lens opacities classification system II (LOCS II). G MARAINI, P PASQUINI, R D SPERDUTO, M BONACINI, M P CARRIERI, R CORONA, P GRAZIOSI, M C TOMBA and S L WILLIAMS. Invest Ophthalmol Vis Sci, 1991, 32, 2400-2403.

Data collected from 3646 eyes in the Italian-American Natural History Study of Age-Related Cataract were used to investigate whether the reliability of the Lens Opacities Classification System II (LOCS II) by the severity of the opacity that is being graded or is influenced by the presence and severity of coexisting opacities. Reliability was assessed by comparing the slit-lamp gradings of two clinical examiners (346 eyes) and the gradings performed at the slit lamp with gradings of photographs (3646 eyes). The severity of cortical and nuclear opacities did not affect the reproducibility of slit-lamp gradings, but clinical grading of posterior subcapsular opacities became more reliable as the severity of the posterior subcapsular opacities increased. More advanced coexisting opacities decreased the agreement in the slit-lamp diagnosis of nuclear, but not cortical or posterior subcapsular, opacities. Comparisons of clinical and photographic gradings showed very good to excellent agreement for nuclear and cortical opacities, regardless of the severity of the specific opacity or the severity of the coexisting opacities. Agreement in diagnosing posterior subcapsular opacities was decreased in eyes with milder posterior subcapsular opacities and in eyes with more severe coexisting nuclear and/or cortical opacities. The effect of the severity of the opacity being graded and the severity of coexisting opacities on the reliability of the LOCS II must be considered in studies that use the system to classify and grade cataracts.

Clinical grading and the effects of scaling. I L BAILEY, M A BULLIMORE, T W RAASCH and H R TAYLOR. Invest Ophthalmol Vis Sci, 1991, 32, 422-432.

In clinical practice, there has been a need to grade the magnitude or the severity of the functions and qualities that are assessed in the examination. It is popular to use a four-step grading scale to categorize the severity of clinical findings. The authors discuss clinical grading scales and their influence on the clinician's ability to detect change. These principles have been applied to grades or measures derived from either objective measuring instruments, subjective tests, or techniques in which the clinician makes subjective judgments. A hypothetical data set was used to show the problems associated with using grading scales that are too coarse. The authors presented a mathematic model that helps to estimate the benefits of using a finer scale. Data were presented from two separate studies, one on visual acuity measurement and the other on grading nuclear opacity, to show the advantages of using finer scales to enhance the sensitivity of clinical measurement. High levels of concordance between independent observations indicated that the grading scale was too coarse and that these scales needlessly reduced the clinician's ability to detect change in the parameter being assessed. For moderate sensitivity, the size of the scale increments should not exceed one third of the standard deviation of the discrepancy, in which case the concordance of paired comparisons would not exceed 37%. For fine clinical sensitivity, the size of the scale increments should not exceed one third of the standard deviation of the discrepancy, in which case the concordance of paired comparisons would not exceed 13%. The theory and evidence presented here could prompt re-evaluations of common methods of clinical grading.

Human crystalline lens phospholipid analysis with age. T E MERCHANT, J H LASS, P MENESES, J V GREINER and T GLONEK. Invest Ophthalmol Vis Sci, 1991, 32, 549-555.

Paired human crystalline lenses (n = 21, patient ages 20-79 years) were extracted for lipids with chloroform-methanol 2:1, using the Folch method. The extracted crude lipids were analyzed at 202.4 MHz by phosphorus-31 magnetic resonance spectroscopy (^{31} P NMR). Fourteen membrane phospholipids were detected including phosphatidylcholine (PC), lysophosphatidylcholine (LPC), phosphatidylcholine plasmalogen (PC plas), phosphatidylethanolamine (PE), phosphatidylethanolamine plasmalogen, lysophosphatidylethanolamine (PA), phosphatidylglycerol (PG), lysophosphatidylglycerol, phosphatidylserine (PS), phosphatidic acid, phosphatidylinositol, sphingomyelin (SPH), and two uncharacterized phospholipids. The uncharacterized phospholipid at 0.13 was the predominant phospholipid, comprising 43.20% of the lens phospholipid profile. A decrease in mole percent of phosphorus concentrations of PE, PC plas, and PC and an increase in SPH correlated with age. The following computed indices decreased with age: PC/PG and PE/PS; PC + PE; (PC + PC plas); and PC/PS. The following computed indices increased with age: (PC + SPH)/(PE + PS), SPH/PG, (PC + SPH)/(PE + PS), LPC/PC, LPE/PE, SPH/PE, and SPH/PC. Changes in membrane phospholipids of the crystalline lens with age as detected by ^{31} P NMR can be used to fingerprint lens maturation.

Effect of decreased retinal illumination on simultaneously recorded pattern electroretinograms and visual-evoked potentials. J FROEHLICH and D I KAUFMAN. Invest ophthalmol Vis Sci, 1991, 32, 310-318.

Sixteen normal subjects and three patients with optic neuritis were studied to determine the effect of decreased retinal illumination on simultaneously recorded pattern electroretinograms (PERG) and visual-evoked potentials (VEP). Using neutral-density filters (NDF), it was found that linear modeling is an

excellent fit for VEP/PERG amplitudes and latencies as log functions of retinal illumination, both for individual eyes and averages of pooled data. Within narrow statistical limits, regression slopes show that mean PERG B-wave and VEP P100 latencies are affected almost identically by decreased illumination, leaving the mean retinocortical time (RCT) virtually unchanged. However, mean B-wave amplitude was greatly reduced at retinal illuminations at which P100 amplitude was unaffected. Of clinical significance was that these latency and amplitude effects were found in each eye tested, whether normal or pathologic. In particular, the RCT in normal subjects was never found to be statistically abnormal due to decreased retinal illumination, and it faithfully represented the optic nerve lesion in the patients with optic neuritis. This result was applied to a population of eight patients with uncomplicated cataracts. The significance of these results is discussed.

Visual adaptation and the cone flicker electroretinogram. N S PEACHEY, K R ALEXANDER, and G A FISHMAN. Invest Ophthalmol Vis Sci, 1991, 32, 1517-1522.

This study examined the hypothesis that changes in the response properties of the human cone ERG during light adaptation represent the recovery of cone system responsiveness toward a dark-adapted value after an initial decrease in responsiveness at adapting field onset. The electroretinographic (ERG) responses to 31.3 Hz flicker were obtained under both dark-adapted and light-adapted conditions for stimulus luminances ranging from -1.42 to +0.82 log cd sec/m^2. At low stimulus luminances, flicker ERG amplitudes were larger under dark-adapted than under light-adapted conditions, consistent with the hypothesis. However, at high stimulus luminances, flicker ERG amplitudes obtained under light-adapted conditions were approximately double those recorded from the dark-adapted eye. Therefore, the increase in cone ERG amplitude that occurs during light adaptation at high stimulus luminances does not represent a return toward a dark-adapted level but instead entails a substantial enhancement above the dark-adapted value, by a mechanism that is presently unidentified.

Relationship of oscillatory potential amplitude to A-wave slope over a range of flash luminances in normal subjects. M A SANDBERG, H LEE, G P MATTHEWS, and A R GAUDIO. Invest Ophthalmol Vis Sci, 1991, 32, 1508-1516.

The effect of flash luminance on the relationship of oscillatory potential (OP) amplitude, as a measurement of inner retinal function, to a-wave slope, as a measurement of photoreceptor function, was evaluated in full-field electroretinograms recorded from normal subjects. The ratio of OP amplitude to a-wave slope was found to be independent of flash luminance over a 3000-fold luminance range. This finding raises the possibility that a reduction in the ratio of OP amplitude to a-wave slope in eyes with media opacities may be used as a sign of inner retinal malfunction. Selected cases are presented to illustrate application of this approach.

Cone electroretinographic change during light adaptation in retinitis pigmentosa. S MILLER and M A SANDBERG. Invest Ophthalmol Vis Sci, 1991, 32, 2536-2541.

Cone electroretinograms (ERGs) to 30-Hz full-field white light were recorded after dark adaptation from 33 patients with retinitis pigmentosa and 8 normal subjects over a period averaging 8.5 min. Most patients and all normal subjects showed increases in amplitude that approached or reached maximum by the end of the recording. Regression analyses revealed that patients with smaller baseline amplitudes tended to show larger and faster increases in relative amplitude than patients with larger baseline amplitudes, whose amplitude changes over time were comparable to those seen in normal subjects. These findings suggest that both the magnitude and kinetics of cone ERG amplitude change to a light-adapting, flickering stimulus are related directly to the level of cone malfunction in retinitis pigmentosa.

Normal change in the foveal cone ERG with increasing duration of light exposure. A WEINER and M A SANDBERG. Invest Ophthalmol Vis Sci, 1991, 32, 2842-2845.

Foveal cone electroretinograms (ERG) were elicited with a stimulator-ophthalmoscope from 24 normal subjects with a 4° stimulus flickering at 42 Hz and centered within a 12° steady surround. The stimulus and surround were presented at retinal illuminances of 4.8 log td and 5.5 log td, respectively, to facilitate visualization of the fundus. Several consecutive averaged responses were evaluated to determine whether increasing duration of light exposure causes an increase in amplitude, as previously found for the full-field cone ERG. On average, amplitude increased by 27% over time, and the linear regression of amplitude on recording number accounted, on average, for 42% of the amplitude variability between consecutive responses. Two subjects had amplitudes that were initially subnormal, based on previously published norms, but that value increased to within the normal range in subsequent recordings. These findings show that a significant change in the cone ERG occurs in the fovea with increasing duration of light exposure at these retinal illuminances, and suggest that, when the stimulator-ophthalmoscope is used, consecutive foveal cone ERGs should be obtained from patients with suspected macular disease to avoid a false diagnosis of retinal malfunction.

Prenatal ethanol exposure alters scotopic and photopic components of adult rat electroretinograms. L M KATZ and D A FOX. Invest Ophthalmol Vis Sci, 1991, 32, 2861-2872.

Ocular malformations and visual deficits are pathognomonic of fetal alcohol syndrome (FAS). However, there are no reports on retinal visual function. To determine if prenatal (human second-trimester equivalent) or prenatal plus 10 days of postnatal (human third-trimester equivalent) ethanol exposure produced scotopic and/or photopic deficits in adult hooded rats, electroretinograph (ERG) was used to examine rod and cone, increment threshold, dark adaptation, and paired-flash amplitude recovery functions. The rhodopsin content per eye also was determined. Five main results were found. First, voltage-log intensity and latency-log intensity functions, generated from single-flash ERGs in fully dark-adapted rats, showed increases in absolute threshold and latency and decreases in response amplitude. Second, cone ERGs had latency increases. Third, there were decreases in the scotopic and photopic critical flicker-fusion frequencies, increment threshold functions, and absolute and relative refractory periods. Fourth, rod sensitivity, range, and rate of dark adaptation were decreased. Fifth, rhodopsin content per eye was decreased. These data showed that prenatal ethanol exposure produces long-term deficits in retinal sensitivity amplitude, light and dark adaptation, temporal processing, and excitability. Larger deficits occurred in the scotopic than photopic system and were produced with an additional 10 days of postnatal ethanol exposure. Alterations in photoreceptors and other cells of the distal retina probably contributed to these deficits. The relevance and applicability of these data to FAS and subclinical alcohol embryopathy have yet to be demonstrated; however, they suggest that similar retinal alterations may occur in human FAS.

LIGHTHOUSE PISART VISION AWARD 1992

Nomination Information

The Lighthouse Pisart Vision Award was established in 1981 through a generous bequest of Mme. Georgette Pisart and is presented by THE LIGHTHOUSE INC. to honor individuals who have made extraordinary contributions to the prevention, cure, treatment, or amelioration of vision impairment or blindness. The award carries a prize of $15,000 and a replica of the Pisart sculpture.

Mme. Georgett Pisart was a longtime Lighthouse volunteer and wido of Fernand Pisart, a Belgian diplomat and businessman. The winner is selected by an Independent panel of judges who are leaders in various disciplines concerned with vision.

Previous recipients of the Lighthouse Pisart Vision Award are Eleanor E Faye, Norman Ashton, Sir John Wilson, Lorenz E Zimmerman, Floyd Ratliff, Carl Kupfer, A Edward Maumenee, Alan M Laties, Robert Machemer, Louise L Sloan, David G Cogan and Lloyd M Aiello.

ELIGIBILITY

Anyone who has made a specific, identifiable, noteworthy contribution(s) to the field of vision is eligible for nomination. Candidates may be from any field that in any way prevents or ameliorates blindness or vision impairment, including, but not limited to, medicine, basic scientific research, optometry, engineering, rehabilitation, or service delivery.

Nominators and candidates may reside in or be citizens of any country.

Nominations may not be made by a candidate or family member.

SELECTION CRITERIA

The individual's accomplishment(s) should have implications beyond his/her immediate locale.

If the achievement(s) is an invention or research finding, it should represent an extraordinary advance in the field.

The work should be of an enduring nature. If the nomination is for leadership, it should demonstrate that the nominee's example has inspired others or continues to do so.

NOMINATIONS

A formal nomination must include the following:

1. **THE NOMINATION STATEMENT.** It should explain the candidate's contribution and how it fulfils the criteria and eligibility standards. This will be the main document used by the selection committee and will serve as the primary information source to tell the public about the winner's achievements. Though there is no prescribed form, the nomination must be double-spaced on no more than five pages and submitted in duplicate.

2. **NOMINATION INFORMATION.** The statement must include the nominee's current address and occupation and complete information about education, professional positions held, and experience. Additional pertinent materials may be attached.

3. **REFERENCES.** The names of three people who are well acquainted with the nominee's work and may be contacted for information must be submitted, along with their complete titles, addresses, and phone numbers. Written endorsements from these people are not required but may be appended.

4. **DEADLINE.** All nominations must be postmarked by April 1, 1992, and mailed to:

Secretary
Pisart Vision Award Committee
The Lighthouse Inc.
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New York, NY 10017
USA

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