DALTONIANA

NEWSLETTER OF THE INTERNATIONAL RESEARCH GROUP ON COLOUR VISION DEFICIENCIES

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IRGCVD NEWS

Membership status

At the present count there are 71 members in arrears for both 1994 and 1995 and 16 members in arrears for 1995 only. Full members are reminded that their entitlement to receive the Proceedings volume for the Pau Symposium (expected publication in 1996) depends on their having paid dues for both 1994 and 1995. All members are reminded that their right to vote in the Directorial Committee election depends on their having paid dues for 1995. Additionally there is a longer term implication. While IRGCVD funds are sufficient to cover the publishers contract for the Pau Symposium proceedings, when the bill is paid we will have no reserves. This will hamper any forward planning and is, of course, financially perilous. It is vital to conserve IRGCVD funds and members, who are still in arrears, are urged to renew their membership immediately using the renewal form enclosed with this issue.

IRGCVD Symposium, Pau, France

The Symposium was well attended by 100 participants and 45 accompanying persons. We enjoyed lively scientific and sumptuous social programmes. The meeting opened with the award of the Verriest Medal jointly to Vivianne Smith and Joel Pokorny and the Verriest Lecture, *How much light reaches the the retina?*, presented by Joel Pokorny, set the tone and standard for the rest of the Symposium. It has been remarked, with justice, that each successive Symposium sets a new standard for the next. It is refreshing to reflect that the IRGCVD is still on a "learning curve" as well as attracting new colleagues from related disciplines. Building on the experience of the workshop session in 1993 at Tübingen the tutorial style workshop and round table discussion on *Variation of Colour Vision: Genotypes and Phenotypes* proved to be a great success. The Symposium was exceptional also in having six invited speakers whose contributions broke much new ground. These were supported by 44 contributed papers and 40 posters. All this took place in the remarkable baroque Saint Louis Theatre within the City Hall. The social programme was quite unforgettable. Excellent lunches were taken in the historic Parliament of Navarre. The welcoming reception by the mayor of Pau was followed by grand tournament of the Basque sport of pelote. We were guided around the Château de Pau and learned much about the deeds of the ever present Henry IV. Another reception and buffet followed at the Parliament of Navarre, hosted by the President of the General Council of the Atlantic Pyrenees. The half day excursion was spent *discovering Béarn* and ended with dinner at the Château de Laas. The final gala dinner was held at the Escaladieu Abbey to the accompaniment of a musical programme on medieval instruments.

Our thanks go to local organizer Jean Leid and his team, Ken Knoblauch, Véronique Leid, Nathalie Casanabe, Christine Inacio and Jocelyne Plantey for their unstinting efforts in arranging such a stimulating, enjoyable and memorable Symposium.

Members Entitlement to the Pau Symposium Proceedings

According to current membership records the following members are in good standing for 1994 and 1995 and will receive a copy of the Pau Symposium Proceedings automatically on publication. All readers are strongly urged to check the list and, if necessary, to advise the General Secretary of any omissions or to bring their membership for 1994 and 1995 up to date in order to ensure entitlement to the Proceedings.

Aarnisalo, Abramov, Adams, Ahnelt, Alexander, Arden, Bailey, Biersdorf, Birch, Bowman, Buck, Burns, Capilla, Cavonius, Cicerone, Cobb, Cohen, Cole, Comerford, Crognale, Dain, Deeb, Derefeldt, Dickinson, Drum, Eisner, Elsner, Erb, Eysteinsson, Fletcher, Foster, Frederiksen, Frumkes, Fusco, Gaudart, Haegerstrom-Portnoy, Hansen, Hedin, Hermes, Hovis, Hukami, Ionica, Jacobs, King-Smith, Kinnear, Kitahara, Knoblauch, Kohler, Krastel, Kremers, Kulikowski, Kurtenbach, Kurusu, Lagerlof, Laird, Lakowski, Lanthony, Lee, Leid, Lingelbach, Machemer, MacLeod, Malbrel, Mantyjarvi, M Marré, Miyahara, Miyahara, Mollon, Montag, Mora-Ferrer, Moreland, Morland, Nagy, J Neitz, M Neitz, Ohta, Parker, Paulus, Pease, Pelizzone, Perez-Carpinell, Pidgeon, Pinckers, Plendl, Pokorny, Pollack, Rokugo, Rositani-Ronchi, Roth, Rovamo, Roy, Ruddock, Sample, Scase, Schneck, Shevell, Shimizu, Smith, Sommerhalder, Spalding, Sperling, Sternheim, Stockman, Swanson, Tamaki, Tamiya, Tanabe, Tausch, Terasaki, Uji, Usui, Uvijls, van Norren, Vienot, Vingrys, Voke, Vola, von Campenhausen, Walraven, Watanabe, Wehrhahn, Werner, W D Wright, Yamade, Yorke, Young, Zrenner, Zucca, Zwas

News from the Pau Symposium

Site of the 25th Anniversary IRGCVD Symposium 1997

At the Members Business meeting, proposals for the site of the next Symposium were presented on behalf of Ghent by the General Secretary and for Göttingen by Barry Lee. The meeting voted in favour of Ghent.

New name for the IRGCVD

Proposals for a shortened name for the Group were discussed by the Directorial Committee and it was agreed to recommend *International Colour Vision Society* as reflecting more appropriately the range of interests and our current stature. The recommendation will be proposed at the next Business Meeting and, if accepted, will take effect immediately following the 1997 Symposium.

Treasurer and Membership Secretary

Ted Sharpe is the new IRGCVD treasurer and he will be assisted in membership matters by Anne Kurtenbach. The address for correspondence is:

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Tel: +49 7071 293734 email: anne.kurtenbach@uni-tuebingen.de
Fax: +49 7071 551326 email: lindsay.sharpe@uni-tuebingen.de

New Editors for the Proceedings and for Daltoniana

Dick Cavonius has taken over the editorship of the Symposium proceedings. He is now dealing with the Proceedings for the Pau Symposium. His address is:

Professor C R Cavonius
Institut für Arbeitsphysiologie an der Universität Dortmund
Ardeystrasse 67
D 44139 Dortmund
Germany

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Fax: +49 231 1084401

Harry Sperling will be taking over the editorship of Daltoniana after this issue. All items of news, literature reviews, off-prints of articles, letters of general interest, notices of meetings should be addressed to him:

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Sensory Sciences Center
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Back Numbers of the 1991 and 1993 Symposium Proceedings

There are some back numbers of the Sydney 1991 and Tübingen Proceedings available to members at very considerable savings on the retail price. An order form is enclosed with this issue.

Cumulative IRGCVD Proceedings Index

Members will have noticed that in the cumulative index published in Colour Vision Deficiencies XII (1995) pp. 541-558 are incomplete. Inadvertently all the contributions for Colour Vision Deficiencies VI (1982) were ommitted. The following list, provided by Professor Joel Pokorny, rectifies the ommission.

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IRGCVD COMMITTEE: CANDIDATES FOR ELECTION

These brief CVs are based on notes provided by the Candidates. A voting form is enclosed with this issue.

Anthony J Adams

PhD Physiological Optics, Indiana University.
1968 Professor of Optometry and Physiological Optics, University of California at Berkeley.
1992 Dean of School of Optometry, University of California at Berkeley.
He has over 200 publications on vision and has a special interest in the early vison changes of diabetics. He has served on the NIH-NRC Committee on Vision and on the Editorial Boards of *Investigative Opthalmology and Visual Science* and of *Optometry and Visual Science.*
1991-1995 Member of IRGCVD Directorial Committee.

Jennifer Birch

Senior Lecturer in Clinical Optometry, City University, London, UK. Optometrist and Founder Member of the IRGCVD. Attended all IRGCVD symposia since 1971. IRGCVD Treasurer: 1983-94. Research interests: Acquired colour vision deficiency (especially in diabetic retinopathy); congenital colour deficiency (characteristics, clinical tests, occupational standards/limitations).

C R Cavonius

BA Wesleyan University; MSc, PhD, Brown University. Former Director, Eye Research Foundation of Bethesda; various posts and fellowships at University of Munich, Cambridge, and Amsterdam. Currently Director, Department of Sensory Physiology and Neurophysiology, Institut für Arbeitsphysiologie and der Universität Dortmund. 1995 IRGCVD Proceedings Editor.

Stephen J Dain

BSc 1968 PhD 1972 The City University. Optometry. Associate Professor, School of Optometry, University of New South Wales. Teaching and research includes colour vision and clinical examination of colour vision and Public Health and Occupational Optometry. Much involved with Standards Australia in preparation of Australian Standards related to colour and eye protection. Member of IRGCVD since 1971.

Jan E E Keunen

Professor and Chairman of the Department of Ophthalmology, the Leiden University Hospital, The Netherlands. Published papers on retinal densitometry, colour matching and the Stiles-Crawford effect with D van Norren (Utrecht) and V.C. Smith and J. Pokorny (Chicago). 1990 Fulbright Scholar at the Visual Sciences Center in Chicago.

Kenji Kitahara

1964 Graduated, 1967 Post-doctoral Fellow, The Jikei University School of Medicine.
1977 Post-doctoral Fellow, University of Michigan.
1980 Lecturer, 1984 Assistant Professor, 1990 Chairman and Professor, The Jikei University School of Medicine.
1990 Member of organising committee IRGCVD regional symposium in Tokyo.
1993-95 Member of IRGCVD Directorial Committee.

Kenneth Knoblauch

BA Psychology, University of Pennsylvania 1975. PhD in Psychology from Brown University (Providence, Rhode Island, USA) 1981. He has published on topics related to chromatic discrimination and colour appearance in colour deficiency, development and aging of colour vision mechanisms and the analysis of results from standard colour vision tests.
1993 Associate Editor of Colour Vision Deficiencies XII.
Currently on the faculty of the Institut de l'Ingenierie de la Vision at the Université Jean Monnet in St. Etienne, France and is also associated with the INSERM Unit 371, Cerveau et Vision in Lyon, France.
1981 Joined the IRGCVD.
1993-95 member of organising committee IRGCVD Symposium in Pau.

Ann Kurtenbach

BSc Biological Sciences, Edinburgh University 1969: MSc in Experimental Psychology, Sussex University 1976: PhD (Biology), Freiburg University 1981. Topic: Retinal Perceptive Fields in the Human Visual System: 1989-today: Research Assistant, University Eye Hospital, Tübingen, Germany. Main topics: Colour Vision in Diabetics, Retinal Mechanisms of Colour Vision.
1991-93 Member of the organising committee IRGCVD symposium in Tübingen.
1995 IRGCVD Membership Secretary

Jean Leid

Graduated as Doctor of Medicine and in Ophthalmology, University of Marseilles. Diplomas in Pharmacology, Mercantile Marine Medicine and in Legal Compensation for Bodily Injury. Currently working as an ophthalmologist specializing in diabetology. Expert court witness in ophthalmology. Teaches a diploma course in colour vision, University of Paris VII. Author of a book and film for teaching colour vision. Research interests in acquired dyschromatopsias especially in diabetes.
1993-95 Member of IRGCVD Directorial Committee and organiser of the IRGCVD Symposium in Pau.

John Mollon

PhD in experimental Psychology, Oxford University 1966-1970. Postdoc with John Krauskopf, Bell Telephone Laboratories, 1970. University Demonstrator, Cambridge University, 1972-76; Lecturer 1976-93 Reader 1993 -. Chairman of the Colour Group of Great Britain, 1991-93.
1991-95 Member of IRGCVD Directorial Committee.

Tony B Morland

ARCS 1988 and ph.D 1992 at Imperial College, London. Has remained at Imperial College as a post doc with Keith Ruddock. His research interests are in colour vision, eye measurements, spatio-temporal visual response in the absence of vestibular function colour constancy in congenital colour defectives and in patients with cortical lesions. Keenly interested in the IRGCVD.

Joel Pokorny

Graduate studies at Columbia University. He received his PhD in 1967 and has been at the University of Chicago since then (Professor, Department of Ophthalmology and Visual Sciences, 1978). He works collaboratively with his wife, Vivianne C. Smith. He has had a strong commitment to the IRGCVD since becoming a member in 1975, and has attended and contributed papers to all the biannual symposia since then. He and Vivianne were the recipients of the 1995 Verriest Medal. He has been a member of the IRGCVD Directorial Committee since 1988.

L Ted Sharpe

BA (Hons), MA. Began colour vision work at University of British Columbia. Spent 6 months at the Optics Section, National Research Council of Canada, Ottawa. PhD at the Center for Visual Sciences, University of Rochester. 3 Years as a NATO post-doc , Experimental Psychology, Cambridge. Honorary secretary of the Kenneth Craik Club and helped organise a NATO International Conference on colour vision at Trinity College in 1982. Since 1983 held Humboldt and Heisenberg Fellowships at the Neurological Clinic of the University of Freiburg. Currently holds a Hermann-und-Lilly Schilling Professur in the Forschungsstelle für Experimentelle Ophthalmologie, University Eye Hospital, Tübingen. Co-edited books on colour vision and on night vision. Member of CIE Technical Committee TC 1-36. 1995 IRGCVD Treasurer.

Harry G Sperling

Professor of Neural Sciences and Director of the Sensory Sciences Center in The Graduate School of Biomedical Sciences and Professor, Ophthalmology in the Medical School of the University of Texas at Houston. Member of the IRGCVD since 1973. He received the Award of Merit of the Retina Research Foundation in 1982 for his research on the effects of intense spectral light on the photoreceptors and the Verriest Memorial Medal of the IRGCVD in 1991. 1991-95 Member of the IRGCVD Directorial Committee. 1995 Editor Daltoniana

Eberhart Zrenner

Chairman of the Department for Pathophysiology of Vision and Neuroophthalmology and Executive Director of the University Eye Hospital of Tübingen. At the Max-Planck-Institute for Physiological and Clinical Research in 1973 in Bad Nauheim, working on electrophysiological recordings, psychophysics of colour vision, recordings from retinal ganglion cells of monkey, and effects of chemical compounds on the function of the visual system. With a Fogarty-Fellowship he worked at the NIH in 1977 and 1978 in the laboratory of Professor Gouras. After habilitation in Physiology he finished his residency in Ophthalmology and led a group on Experimental Ophthalmology at the University Eye Hospital in Munich. He is Section-Editor of Vision Research as well as of Neuroophthalmology and he served on the board of the International Society of Clinical electrophysiology (as president since 1991). He has received several scientific awards and published together with his co-workers approximately 160 papers. 1993 Organiser IRGCVD Symposium Tübingen. 1991-95 Member of the IRGCVD Directorial Committee.

Bill Swanson

BA in Mathematics : New College (Sarasota, Florida). PhD in Biophysics and Theroetical Biology: University of Chicago. Fellowship in Ophthalmology: University of Chicago. Currently Senior Research Scientist, Retina Foundation of the Southwest; Adjunct Associate professor of Ophthalmology, University of Texas Southwestern Medical Center at Dallas
Memberships: IRGCVD, ARVO, International Perimetry Society, American Academy of Ophthalmology, Optical Society of America, Sigma Xi. Research focuses on quantitative analysis of acquired colour vision defects in terms of underlying cellular pathophysiology. Recent publications have analysed effects of disease on foveal colour vision, and current research focuses on peripheral colour vision in two diseases: glaucoma and retinitis pigmentosa.

Françoise Vienot

Graduated in physics in Paris. Spent a few months at the Rensselaer Colour Measurement Laboratory with Professor F W Billmeyer. She has been trained in vision by Professor Y Le Grand and is a member of the laboratory he had formerly headed. She is mainly engaged in colorimetry and visual photometry in the mesopic range, and is interested in spatio-chromatic interactions and in colour imaging. She is the chair of the technical committee of the CIE "Chromaticity diagram with physiologically significant axes".

Obituary: Wolfgang Jaeger (1917-1995)

The IRGCVD joins the international community of ophthalmologists and visual scientists in mourning for Wolfgang Jaeger, our former president, who died on October 15th, 1995, after a life dedicated to ophthalmology, humanity and colour science.

Wolfgang Jaeger's first scientific work was concerned with colour vision and he continued to treat this subject throughout a life full of enormously fruitful activities in the various fields of ophthalmology, ocular pathophysiology, ophthalmic genetics, methodological and instrumental developments and of the history of ophthalmology and colour science.

All through his life, he felt and experienced a particular connection and friendship with those sharing an interest in colour vision. His personal entry into the company of colour investigators was effected through his organisation in 1995 of the Heidelberg International Symposium on Colour Vision. This early precursor of the regular biennial meetings of the IRGCVD was, in a way, a step towards the re-entry of Germany into the international scientific community. On many occasions, he gratefully mentioned the cordiality extended to him by the participants, and the blossoming friendships which were formed at the Heidelberg Symposium and at the later IRGCVD conferences. In 1969, he was one of the founder members of our Research Group and was President during the quadrennium 1985-1989.

He was particularly responsive to friendship in frankness and humanity, because his own life experience had, during the Nazi war, confronted him with suppression and inhumanity in a two-fold life-threatening manner: by his close connections with the resistance movement of the "White Rose" and by a severe wound he received during the war. Originally a student of history, these experiences lead him to medicine. After completing his studies in Munich, he became a co-worker of Ernst Engelking at the Department of Ophthalmology in Heidelberg.

In 1958, already nominated director of the Essen Eye Hospital, he was offered the chair of the Department of Ophthalmology in Heidelberg University. This chair, by tradition, is connected with the position of Secretary of the German Ophthalmological Society, and Wolfgang Jaeger agreed to take over both functions and he fulfilled these tasks during the subsequent 28 years.

Despite the enormous burden of clinical and administrative duties, he successfully pursued many scientific topics, including colour vision. Some of the subjects he was working on in this field may indicate the breadth of his expertise:

- colour vision in large fields using surface and spectral colours, yielding evidence of remnant "forbidden cones" in achromatopsia and in dichromacy;
- spectral sensitivity as evaluated by psychophysical and electrophysiological procedures in heredo-degenerative retinal disease;
- description of the tritan defect in dominant infantile optic atrophy, and of pseudo-protanomaly in various affections of the macula;
- development of a tritanomaloscope based on the Engelking-Trendelenburg equation;
- methodological developments in colour perimetry;
- application of the principle of chromatic acuity for early detection of tonic opticopathies;
- studies on colour deficits as indicators of side effects of drugs;
- studies on genetics of colour defects;
- studies on colour naming, colour constancy and colour memory;
- studies on the development of colour science from the 18th to the 20th century;
- re-evaluation of Goethe's studies on colour defectives including examination of a daltonian descendant of Goethe's original subject.

Wolfgang Jaeger's main achievement is unquestionably the close connexion of colour vision and clinical ophthalmology, the correlation of patho-physiologic and ophthalmologic findings. Colour vision, from Wolfgang Jaeger's point of view, is no theoretical issue, but a useful tool in ophthalmologic diagnosis and patient care. In his contributions and remarks at IRGCVD meetings, he would bring discussions down to earth again, when he asked for a clinical use of an apparently sophisticated procedure.

Wolfgang Jaeger was a stimulating personality, incredibly effective in generating ideas and associations and getting together human beings and brains to multiply their efficacy. The diversity of his interests - from history to literature, from painting to music (he was himself a performing viola player) - led many people to him, who found their ideas accepted, reflected and enriched in the most inspiring manner. His activities extended far beyond Ophthalomolgy, as his books from *The Cure of the Blind as Shown in Art* to a re-edition of Rubens illustrations to Franciscus Aguilonius' *Optics*. By these capabilities he became a core of condensation for cooperation and, the best basis of the exchange of ideas, friendship.

Wolfgang Jaeger had a good sense of humour and enjoyed to smile and laugh together with those around him. One of his broadly smiling but honestly given recommendations to his co-workers concerned the annual Congress of the German Ophthalmological Society, organized largely by himself: "You should attend as many of the lectures as possible. However, bear in mind that there is an even more physiological and effective approach for communication available: during the programme breaks!"

The spirit of community which, despite the respect due to his emminence, closely connected Wolfgang Jaeger with his co-workers, became manifest with a torchlight procession dedicated to him on the occasion of his 70th birthday, when the stanzas of Robert Burns resounded in the Jaegers' garden: "Should auld acquaintance be forgot ... ?"

Humanity and community are reflected by two extraordinary honours bestowed on him: the German Retinitis Pigmentosa Foundation, a self-help association of patients, elected him as honorary member and he was elected in common with his wife Hildegard Jaeger as honorary member of the German Ophthalmological Society.

In grateful affection for the exemplary physician, versatile scientist and stimulating professor, the paternal friend and academic of universal culture, Wolfgang Jaeger will live on in our memory.

Herman Krastel

Literature Survey

Le devenir des familles protan + deutan de Franceschetti et Klein (1949 et 1956), une génération après. (The progeny of the two protan + deutan families described by Franceschetti and Klein (1949, 1956), one generation later. A ROTH, D KLEIN, F PACCOLAT, D HERMÈS, M PELIZZONE, J L MANDEL and R FEIL. Ophtalmologie, 1989, 3: 275-278.

The progeny of the couple of which the husband was protanope and the wife deuteranope (Franceschetti, 1949) has been examined (3 generations) in 1986 and 1987. This couple had 4 children, of which 3 sons are deutan and 1 daughter, a double carrier, is phenotypically normal. This girl, in her turn and in exemplary fashion, has 3 children: 1 daughter, being a simple carrier, is phenotypically normal, 1 son is protan and 1 son deutan. The study of the genomic DNA of 3 normal subjects reveals the presence of two genes responsible for green and one gene responsible for red: the genomic DNA of a protanomalous subject shows a modification of the gene for red, while that of two deuteranopes shows an absence of the genes responsible for green. The descent of the second couple in which the husband was deuteranope and the wife protanope (Franceschetti and Klein, 1956) is exclusively of female sex. Therefore it comprises only phenotypically normal persons - The Authors.

The normal color vision evaluated with FM 100-hue test. S HUANG, L WU and D-Z WU. Eye Science, 1993, 9: 158-160.

One hundred and twenty normal subjects (240 eyes) aged from 10 to 69 were tested with FM 100-hue test. They were divided into 6 groups according to their age. It was shown that there were no statistically significant differences in the total error score (TES) between the males and females or between the right and left eyes, but there existed some relationship between the TES and age. The total error score (TES) was the lowest in the 20-29 age group and increased gradually with aging. The analysis of the partial error score (PES) in each age group showed that the PES was the lowest in 20-29 age group and that the larger PES appeared around the tritan axis of with age increasing - The Authors.

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 pseudoprotanomly 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.

Exposure times in visual experiments. L R RONCHI. Atti Fond. G. Ronchi, 1994, 68: 119. *A comprehensive review monograph.*

Le post-immagini. S VILLANI. Atti Fond. G. Ronchi, 1994, 6: 1095-1106. *A bibliographical review on after-images.*

Age-related changes in normal and cataractous human lens crystallins, separated by fast-performance liquid chromatography. P C PEREIRA, J S RAMALHO, C J FARO and M C MOTA. Ophthalmic. Res., 1994, 26: 149-157.

Testing the individual: electrophysiological tests, the cortical visual evoked potential. Atti Fond. G. Ronchi, 1995, 1: 75-82. *A short introductory review.*

Daltonic Painter (J J Peintre Daltonien). P LANTHONY. J. Fr. Ophtalmol., 1994, 17 (10): 596-602.

Mr J J Painter has been a professional artist for thirty years. On clinical examination of the color vision by pseudo-isochromatic plates, City University Colour Vision Test, standard and desaturated Panel D-15, Farnsworth 100-hue test and Nagel's anomaloscope evidenced a typical hereditary deuteranopia. Nevertheless, the recognition and the denomination of coloured samples, presented singly or in simultaneous chromatic contrast, evidenced only a few errors. In an interview, the subject explained his difficulties with colours, mainly with green, and the procedures used to avoid mistakes in painting: knowledge of the names of colors written on tubes; precise order of arranging the tubes; use of a palette restricted to some basic hues, avoiding green. The subject's artistic technique is based on drawing, on better perceived colours (i.e. the blues) and on value contrasts. He also enumerated his difficulties with colours in casual situations: clothes, traffic, food. Some reproductions of the works of the painter illustrate this study - The Author.

Nature of the pupillary responses evoked by chromatic flashes on a white background. E KIMURA and R S L YOUNG. Vision Res., 1995, 35 (7): 897-906.

Color flashes on a steady-white background are classically used to isolate the response of the chromatic (color-opponent), as opposed to achromatic (luminance), channel in psychophysical investigations. The present study shows that pupillary responses evoked by such stimuli behave as if they are composed of functionally separable components. One component has a temporally transient waveform and has an action spectrum that is similar to the spectral sensitivity curve of the psychophysical chromatic channel. The present study discusses the possibility that the pupillary response is mediated by phasic (M-like) neurons and/or by tonic (P-like) neurons - The Authors.

Horizontal cells and cone photoreceptors in primate retina: a Golgi-light microscopic study of spectral connectivity. P AHNELT and H KOLB. J. Comp. Neurology, 1994, 343: 387-405.

Horizontal cells and cone photoreceptors in primate retina: a Golgi-electron microscopic study of spectral connectivity. P AHNELT and H KOLB. J. Comp. Neurology, 1994, 343: 406-427.

Purpose: *Study the connectivity between spectral subtypes of cones and horizontal cells to investigate the presence of spectral connectivity patterns at the first synaptic level in primate and human retina.* Methods: *S-cones can be differentiated by distinctive morphological criteria from L-/M-cones. At the light microscopical level connections of the three primate and human retinal horizontal cell types (HC's) to cone pedicles were assessed by super-imposing the cone inner segment mosaic on the mosaic of Golgi-impregnated HC dendritic terminal clusters. At the electron microscopical level the presence or absence of dendritic contacts to S-cone pedicles was determined by examining EM-serial sections and making reconstructions of examples of the HC-types.* Results: *HI and HIII horizontal cells did not contact all cones located within their dendritic fields uniformly. They either made no or only sparse contact with S-cone terminals (HI) or avoided them completely (HIII). HII cells, on the other hand, with their more diffusely branched dendrites, appeared to contact all overlying cone pedicles, and, in contrast to HI and HIII cells, directed a disproportionately larger number of dendrites to S-cone positions. In addition the terminals of the HII axon contacted S-cones exclusively. B-cone pedicles and the related neuropil appear to form a vitread sublayer of the outer plexiform layer (OPL) here named OPLb, in comparison to OPLa, where the M- and L-cone pedicles end.* Conclusions: *A chromatically selective weighting pattern is present at the first synaptic level in human retina and may influence color processing in the inner plexiform layer and the receptive field properties of ganglion cells - The Authors.*

Spectral transmission of the optical media of the human eye with respect to keratitis and cataract formation. W AMBACH, M BLUMTHALER, T SCHÖPF, E AMBACH, F KATZGRABER, F DAXECKER and A DAXER. Documenta Ophthalmologica, 1994, 88: 165-173.

Relationship between spectral transmittance and slit lamp color of human lenses. T J T P VAN DEN BERG and J FELIUS. Invest. Ophthalmol. Vis. Sci., 1995, 36: 322-329.

Purpose: *To study the relationship between subjective lens color as observed with slit lamp biomicroscopy and spectral transmittance of the lens. To propose a model for this relationship to derive quantitative information on lens pigmentation from slit lamp observation.* Methods: *Twenty-nine normal lenses, from donors aged 14 to 86 years, were used. The fraction of light transmitted from a narrow beam was measured as function of wavelength. The spectra were fitted with the one-parameter TL model of Pokorny et al. The relationship between this parameter and the color grading form Chylack et al. (lens opacity classification system III nuclear color score) was established.* Results: *After slight adaptation of the TL model, the shapes of the transmittance spectra corresponded closely to the TL model (average residual error 0.05 log units). Log transmittance and lens opacity classification system nuclear color score were closely related (r = 0.90, 0.77 and 0.55 for 400, 500 and 602 nm, respectively).* Conclusions: *A mathematical relationship between TL parameter and lens opacity classification system nuclear color score could be established to predict lens transmittance from lens opacity classification system nuclear color score. This relationship was successful in predicting the correction for lens absorption needed in blue-on-yellow perimetry - The Authors.*

The influence of age-related cataract on blue-on-yellow perimetry. I D MOSS, J M WILD and D J WHITAKER. Invest. Ophthalmol. Vis. Sci., 1995, 36: 764-773.

Purpose: *The influence of cataract on the blue-on-yellow visual field is unknown. The aim of the study was to compare the effect of age-related cataract on the normal blue-on-yellow (B-Y), yellow-on-yellow (Y-Y) and white-on-white (W-W) visual field.* Methods: *Forty normal subjects (age range, 60 to 81 years) randomly performed B-Y, Y-Y, and W-W perimetry using a modified Humphrey field Analyser 640 (HFA) (program 24-2). Twenty age-matched patients with cataract underwent the same testing paradigm. Cataract was classified using the LOCS II system. Ocular media absorption was measured with the HFA by determining the difference in scotopic sensitivity to 410-nm and 560-nm stimuli. Forward light scatter was measured by the direct compensation technique of van den*

Berg. Unweighted mean deviation (MD), short-term fluctuation, and corrected pattern standard deviation indices were calculated for each patient with cataract for each of the three stimulus combinations. **Results:** *Cataract produced an adverse effect on the MD (i.e., a more negative MD) in all patients for each of the three stimulus combinations. The magnitude depended on the degree and type of cataract and was highly correlated with forward light scatter. The attenuation in sensitivity was greatest for the B-Y and W-W stimulus combinations; the B-Y field was preferentially affected by posterior subcapsular cataract and the W-W field by anterior cortical cataract.* **Conclusions:** *Cataract predominantly causes a general reduction B-Y sensitivity. Caution therefore needs to be exercised in the interpretation of the B-Y visual field in patients in whom glaucoma and cataract coexist - The Authors.*

Ultraviolet and green light cause different types of damage in rat retina. T G M F GORGELS and D VAN NORREN. Invest. Ophthalmol. Vis. Sci., 1995, 36: 851-863.

Rod phototransduction in retinitis pigmentosa. Distinguishing alternative mechanisms of degeneration. S SHADY, D C HOOD and D G BIRCH. Invest. Ophthalmol. Vis. Sci., 1995, 36: 1027-1037.

Ethambutol alters spinule-type synaptic connections and induces morphologic alterations in the cone pedicles of the fish retina. K KOHLER, E ZRENNER and R WEILER. Invest. Ophthalmol. Vis. Sci., 1995, 36: 1046-1055.

Photoreceptor sensitivity changes explain color appearance shifts induced by large uniform backgrounds in dichoptic matching. E J CHICHILNISKY and B A WANDELL. Vision Res., 1995, 35 (2): 239-254.

Spatio-temporal model for subjective colours based on colour coded ganglion cells. E D GRUNFELD and H SPITZER. Vision Res., 1995, 35 (2): 275-283.

We propose a mathematical model for the generation of the subjective colour phenomenon through Benham's disk stimuli. The model relates to the spatial and temporal properties of three colour coded retinal ganglion cells: L^+/M^-, M^+/L^- and $S^-/(L+M)^+$ [or $(L+M)^-/S^+$]. It is suggested that the phenomenon is based on both the opponent mechanisms in the cells' receptive fields, and the "rebound response" - a common cell response to turning off an inhibitory stimulus (nonlinear cell dynamics). A physiological mechanism is suggested for this response. The integrated cell responses to Benham disk-stimuli create imbalances between the colour pathways that are interpreted as actual colours. The model also predicts the shift in the perceived colours when the disk rotation rate is varied - The Authors.

A closer look at the dependence of neon colour spreading on wavelength and illuminance. P BRESSAN. Vision Res., 1995, 35 (3): 375-379. (Letter to the Editor).

Network simulations of retinal and cortical contributions to color constancy. S M COURTNEY, L H FINKEL and G BUCHSBAUM. Vision Res., 1995, 35 (3): 413-434.

A biologically-based neural network simulation is used to analyze the contributions to color perception of each of several processing steps in the visual system from the retina to cortical area V4. We consider the effects on color constancy and color induction of adaptation, spectral opponency, non-linearities including saturation and rectification, and spectrally-specific long-range inhibition. This last stage is a novel mechanism based on cells which have been described in V4. The model has been tested with simulations of several well known psychophysical color constancy and color induction experiments. We conclude from these simulations the following: (1) a simple push-pull spectrally specific contrast mechanism, using large surrounds analogous to those found in V4, is very effective in producing general color constancy and color induction behavior; (2) given some spatio-temporal averaging, receptor adaptation can also produce a degree of color constancy; (3) spectrally opponent processes have spatial frequency dependent responses to color and brightness contrast which affect the contribution of the V4 mechanism to color constancy in images with nonuniform backgrounds; and (4) the effect of the V4 mechanism depends on the difference between center and surround while the effect of adaptation depends on the total sum of inputs from both center and surround and therefore the two stages cooperate to increase the range of stimulus conditions under which color constancy can be achieved - The Authors.

Detection of blue under chromatic adaptation: the effects of stimulus size and eccentricity. A IIVANAINEN and J ROVAMO. Vision Res., 1995, 35 (5): 589-600.

We measured thresholds for the perception of blue under chromatic adaptation to white, green, yellow or red at the eccentricities of 0-70 deg in the temporal visual field of four subjects. We used a series of stimulus sizes at each eccentricity, without a prior assumption of any peripheral size-scaling factor. The CIE 1976 UCS (u', v') chromaticity coordinates corresponding to blue perception were subtracted from the chromaticity coordinates of the adaptation field in order to obtain the threshold

differences (du', dv') in chromaticity coordinates. Spatial scaling factors for the perception of blue were obtained by non-linear regression. (E_2 ÷ 5 deg) refers to the eccentricity at which stimulus diameter had to be doubled in order to maintain performance found at the eccentricity of 2.5 deg. E_2 for the perception of blue tint varied from 1.2 to 36 deg depending on the state of chromatic adaptation and subject. For the perception of blue tint in yellow three subjects and for the perception of blue tint in red one subject had no spatial scaling factor that would make performance independent of eccentricity. Thus, spatial scaling does not always work - The Authors.

Field additivity of the middle-wavelength cone pathway under various test and field configurations. J A SCHIRILLO and A REEVES. Vision Res., 1995, 35 (5): 601-611.

The field additivity of the M-cone pathway was measured with psychometric functions at 10 times absolute threshold on monochromatic fields and their mixtures. Observers detected a 500 nm test on 530 or 610 nm fields, and a 530 nm test on 481 or 622 nm fields. For both sets of wavelengths, field additivity held with the 1 deg test, 10 deg field condition which defines $\pi 4$ and with the 3.6 min arc test on a 8.6 min arc field used to isolate the M fundamental by Stockman [(1983) Ph.D. thesis, Trinity College, Cambridge University, Cambridge]. Sub-additivity occurred for a 1 deg test on a 1 deg field, a condition for Foster's "spectral sharpening" which may evince opponency - The Authors.

Rayleigh matches and unique green. G JORDAN and J MOLLON. Vision Res., 1995, 35 (5): 613-620.

There are recurrent reports that Rayleigh matches are biomodally distributed in the colour-normal male population. Similar claims have been made for the distribution of the spectral locus of unique green. Moreover, a positive correlation has sometimes been reported between Rayleigh matches and unique green. Using a computer-controlled Maxwellian colorimeter and bias-free psychophysical methods, we measured both variables for 97 colour-normal male observers. We do not find a bimodal distribution either of Rayleigh matches or of settings of unique green. Nor do we find any correlation between the two variables. However, we do observe a very significant relationship between the lightness of the subject's iris and the wavelength that he judges to be unique green - The Authors.

Color appearance with sparse chromatic context. J W JENNESS and S K SHEVELL. Vision Res., 1995, 35 (6): 797-805.

Proximity judgments in color space: tests of a Euclidean color geometry. S M WUERGER, L T MALONEY and J KRAUSKOPF. Vision Res., 1995, 35 (6): 827-835.

We describe two tests of the hypothesis that human judgments of the proximity of colors are consistent with a Euclidean geometry on color matching space. The first test uses proximity judgments to measure the angle between any two intersecting lines in color space. Pairwise estimates of the angles between three lines in a plane were made in order to test the additivity of angles. Three different color proximity tasks were considered. Additivity failed for each of the three proximity tasks. Secondly, we tested a prediction concerning the growth of the variability of judgments of similarity with the distance between the test and reference stimuli. The Euclidean hypothesis was also rejected by this test. The results concerning the growth of variability are consistent with the assumption that observers use a city-block metric when judging the proximity of colored lights - The Authors.

Human processing of colour information in the chromatic-frequency domain. J ROMERO, J L NIEVES and A GARCIA-BELTRAN. Vision Res., 1995, 35 (6): 867-871.

On the basis of MacAdam's data, we have computed a psychophysical function which characterizes the transference of the colour information processed by the human visual system in the chromatic frequency domain. This function, obtained using chromatic-discrimination criteria, shows a cut-off frequency between 0.01375 and 0.02 c/nm, depending upon the colour-tolerance units adopted - The Authors.

A reflectometric technique for assessing photoreceptor alignment. J-M GORRAND and F DELORI. Vision Res., 1995, 35 (7): 999-1010.

Clinical studies of photoreceptor orientation are limited by the fact that psychophysical methods for measuring the Stiles-Crawford effect are time consuming and require excellent co-operation from the subject. We have developed a novel instrument, the photoreceptor alignment reflectometer (PAR), that determines photoreceptor alignment by measuring the distribution in the pupil of light reflected by one retinal location. This determination is accomplished in a measurement time of 4 sec and requires minimal co-operation from the subject. The technique is not significantly affected by reflections at the limiting membrane, or by changes in entrance and exit pupil configuration, or by location of bleaching light entry. The PAR was used to measure the orientation of foveal

photoreceptors, their directionality, and the ratio of directional to diffuse flux in 20 normal subjects ranging in age from 20 to 60 yr - The Authors.

Migraine phosphenes and the retino-cortical magnification factor. O-J GRUSSER. Vision Res., 1995, 35 (8): 1125-1134.

Enhanced S cone syndrome: evidence for an abnormally large number of S cones. D C HOOD, A V CIDECIYAN, A J ROMAN and S G JACOBSON. Vision Res., 1995, 35 (10): 1473-1481.

The cellular basis of the hypersensitivity of the S (blue) cone system in patients with enhanced S cone syndrome was examined by analyzing ERGs from three patients. The patients had large a-waves in response to the blue and white flashes. These a-waves were shown to be driven nearly entirely by the S cones. Although these S cone a-waves were 4-6 times the size of the normal L/M cone a-wave, they are of the same form, and could be quantitatively described with the same model previously shown to fit cone a-waves. We propose that the retina of these patients has many more S cones than the normal retina and that these cones replace some of the normal L/M cones and many of the rods - The Authors.

Peripheral cone contrast sensitivity in glaucoma. J FELIUS, T J T P VAN DEN BERG and H SPEKREIJSE. Vision Res., 1995, 35 (12): 1791-1797.

Colour vision tests for detection of glaucomatous damage frequently suffer from two problems: most tests are confined to foveal vision, whereas defects tend to appear first extrafoveally; and the modulation directions in colour space are not optimal. This paper deals with peripheral testing à la Yu, Falcao-Ris, Spileers and Arden [(1991) Investigative Ophthalmology and Visual Science, 32, 2779-2789], and investigates whether there are modulation directions that show preferential sensitivity reduction in glaucoma. In 14 eyes with early glaucoma, 17 risk eyes and 10 normals, 12 deg peripheral colour contrast thresholds were determined for L, M, S, L - M and L + M test directions. Threshold elevations were correlated in all test directions, with S modulation yielding the largest elevations - The Authors.

Changes in light scattering intensity of the transparent lenses of subjects selected from population-based surveys depending on age: analysis through Scheimpflug images. K FUJISAWA and K SASAKI. Ophthalmic. Res., 1995, 27: 89-101.

Changes of color vision in ocular hypertension. M MÄNTYJÄRVI and K TUPPURAINEN. International Ophthalmology, 1995, 18: 345-349.

Fifty-six ocular hypertension (OHT) patients were examined for 2-3 days in the Eye Clinic of Kuopio University Hospital. No glaucomatous changes were found. Twenty-seven of them were found to have several risk factors for developing glaucoma and medication was started. Twenty-nine of the patients did not show risk factors and had no medication. Color vision was examined with the Farnsworth-Munsell 100 (FM 100) hue test and Besançon anomalometer, later Color Vision Meter 712 at the beginning of the study and 3 years later. None of the 56 patients showed any glaucomatous changes after 3 years of the study. In the treatment group, the FM 100 test showed significantly (paired t-test, $p = 0.004$) improved error scores after 3 years. In the non-treatment group, 19 patients did not develop risk factors: they had no significant changes in the color vision results. In 10 patients of the non-treatment group, risk factors had developed with elevated intraocular pressure and medication was started for them after 3 years. Their color vision results in the blue anomalous quotient (AQ) of the anomalometer had significantly shifted to the blue part of the equation (paired t-test, $p = 0.04$). The other color vision results had not changed significantly. The significantly improved FM 100 scores in the treatment group could mean, that the treatment has a beneficial effect for the OHT eyes as risk for developing glaucoma. The significant shifting of the blue AQ towards the blue part of the equation in the eyes with elevated pressure after 3 years could mean that minimal change in blue color vision measured by a blue anomaloscope might be a risk factor for glaucoma development - The Authors.

Sequence and evolution of the blue cone pigment gene in old and new world primate. D M HUNT, J A COWING, R PATEL, B APPUKUTTAN, J K BOWMAKER and J D MOLLON. Genomics, 1995, 27: 535-538.

The sequences of the blue cone photopigments in the talapoin monkey (Miopithecus talapoin), an Old World primate, and in the marmoset (Callitrhix jacchus), a New World monkey, are presented. Both genes are composed of 5 exons separated by 4 introns. in this respect, they are identical to the human blue gene, and intron sizes are also similar. Based on the level of amino acid identity, both monkey pigments are members of the S branch of pigments. Alignment of these sequences with the human gene requires the insertion/deletion of two separate codons in exon 1. The silent site divergence between these primate blue genes indicates a sparation of the Old and New World primate lineages around 43 million years ago - The Authors.

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