DALTONIANA

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The bulletin of the International Colour Vision Society

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Daltoniana on the web

Welcome to the 10th edition of the web based **Daltoniana**. This edition will be transmitted by email and mailed to members from locations in North America, Europe and Australasia.

Contents

Officers and Committee

President	André Roth
General Secretary	Ken Knoblauch
Treasurer	Ted Sharpe
Membership Secretary	Anne Kurtenbach
Daltoniana Editor	Stephen Dain
Proceedings Editors	John Mollon , Joel Pokorny, Ken Knoblauch
Committee	Jenny Birch , Dick Cavonius ,Stephen Dain , Kenji Kitahara , Barry Lee , Jean Leid , John Mollon , Jack Moreland , Joel Pokorny , Eberhart Zrenner

Minutes of the Directors' meeting of the ICVS, July 13, 2001

The meeting was called to order at 9h30 on July 13, 2001 at Cambridge University, Cambridge UK.

The minutes of the last meeting were adopted unanimously.

Membership The membership has gone up since the 1999 meeting. We can probably attribute this largely to the "200 for 2000" campaign. We will continue this policy of letting members pay for a two year membership at a lower fee than for individual years, since it seems to guarantee participation in years between the biannual meetings. The need to encourage student memberships was discussed.

Finances L. T. Sharpe gave the treasurer's report. The principle cost to the society is the publication of the proceedings. If we could hold down the price of the proceedings, we could offer additional incentives to students to join (*e.g.*, travel grants). The proposal to offer the students the proceedings as part of their regular (student) membership fee was adopted unanimously.

Future Meetings S. Buck presented details of the preparation for the Seattle meeting to be held in July 2003. The meeting will run from a Friday through Tuesday as previous meetings have done. The possibility of holding the meeting in Lyon or Brasil in 2005 was discussed.

Committee Nominations The committee nominated K. Knoblauch for General Secretary. The committee also discussed nominations for the board of directors.

Committee for Verriest Medal Organization The organization selection procedures and the role of the Director's in the selection of the Committee for the Verriest Medal (CVM) and in the nomination process were discussed. The following members of the society were nominated for the next CVM: B. B. Lee (coordinator), J. Pokorny, M. Neitz, F. Viénot, S. Tanabe and L. T. Sharpe.

Publicity Need to encourage all members to contribute their email addresses was discussed. Will enquire if members are willing to receive Daltaniana over email .rtf format. Discussed the possibility of changing the domain name of the web site and shortening it (*e.g.*, www.xxx.com). Discussed the possibility of web based forms for membership renewal.

The venue of future proceedings was discussed. The next proceedings will appear as a book. The possibility of publishing with a low cost Russion publisher was entertained. Suggestions for future proceedings to appear as special issues of a journal were discussed. Two possibilities are *The International Journal of Ophthalmology* and *Neurophthalmology*. Questions as to the citability on MedLine, the availability electronically and the tolerance of the normal subscribers to our proceedings (on a biannual basis) were discussed.

Revision of Bye-laws A proposed revised set of bye-laws was submitted by J. Birch. The Bye-laws committee will evaluate these for the next meeting.

Agenda for General Business Meeting The general business meeting was discussed. Sites for future symposia and special topics for the next meeting will be raised. A memorian for A. J. L. G. Pinckers will be presented. J. Leid will make a presentation on the annual report of the French Ophthalmological Society which will be on Color Vision.

Other Business E. Zrenner discussed the DIN norm 66160 on anomaloscopy for red/green color deficiencies which is undergoing a 5 year review. German speakers of the board will review it. J. Birch discussed the continued interest in standards in some fields (*e.g.*, aviation) and the need for availability of equipment for testing.

Next Meeting of the Directors The next meeting of the directors will be scheduled during the Seattle meeting in 2003.

The meeting was adjourned at 12h03.

Next Symposium

Friday, July 11, through Tuesday July 15, 2003. The venue will the beautiful University of Washington campus in the heart of Seattle.

Proceedings of the Cambridge Symposium

The proceedings of the ICVS 2001 Symposium will be published by Oxford University Press as an independent hard-bound book and will be widely distributed. The Editors are J. D. Mollon, J. Pokorny and K. Knoblauch.
The volume will contain the following invited papers:
J. J. Ruprecht and G. F. X. Schertler "Electrons and X-rays reveal the structure of rhodopsin"
Vivianne C. Smith and J. Pokorny "Psychophysical correlates of Parvo- and Magno-cellular function"
D. I. A. MacLeod "Colour discrimination, colour constancy nad natural scene statistics"
J. J. Koenderink "Schopenhauer's 'parts of daylight' in the light of modern colorimetry"
All papers are being refereed and the refereeing process is currently being completed. Oxford University Press will be sending contracts and copyright transfer forms to all contributors. Under the arrangements that the Editors have made with the Press, all first authors will receive a free copy of the book; and it will be possible to order reprints. Independently, the Society will, as traditionally, supply a copy of the book to each member who is fully paid up for the relevant two-year period.
The original web site for the conference (http://www.icvs2001.org.uk/) is still maintained and information about the progress of the Proceedings volume will be recorded there as the editing progresses.

Website news

We have been experiencing multiple problems with the website and trying to assemble this edition of Daltoniana. So my profuse apologies for the delays in Daltoniana and the lack of website.
At the time of writing, I believe the reasons for the problems have all been identified and are soluble. The host computer has been changed from an ageing PowerMac 7220 (6 years old is positively geriatric for a computer) to a Mac G4. At present it is being hosted by the web sharing facilties of MacOS which has necessitated some temporary (I hope) changes.
http://orlab.optom.unsw.edu.au/icvs is available, do not use a trailing / but the links and image don't work for the moment. As soon as new software is obtained, the set up will be returned to its original state in full.
Stephen Dain

Abstracts of color vision papers. Compiled by Joel Pokorny

ANATOMY AND PHYSIOLOGY: RETINA

Hanazawa, A., A. Mikami, P. Sulistyo Angelika, et al. "Electroretinogram analysis of relative spectral sensitivity in genetically identified dichromatic macaques." Proc Natl Acad Sci U S A **98**: 8124-8127, 2001.

The retinas of macaque monkeys usually contain three types of photopigment, providing them with trichromatic color vision homologous to that of humans. However, we recently used molecular genetic analysis to identify several macaques with a dichromatic genotype. The affected X chromosome of these animals contains a hybrid gene of long-wavelength- sensitive (L) and middle-wavelength-sensitive (M) photopigments instead of separate genes encoding L and M photopigments. The product of the hybrid gene exhibits a spectral sensitivity close to that of M photopigment; consequently, male monkeys carrying the hybrid gene are genetic protanopes, effectively lacking L photopigment. In the present study, we assessed retinal expression of L photopigment in monkeys carrying the hybrid gene. The relative sensitivities to middle- wavelength (green) and long-wavelength (red) light were measured by electroretinogram flicker photometry. We found the sensitivity to red light to be extremely low in protanopic male monkeys compared with monkeys with the normal genotype. In female heterozygotes, sensitivity to red light was intermediate between the genetic protanopes and normal monkeys. Decreased sensitivity to long wavelengths was thus consistent with genetic loss of L photopigment.

Calkins, D. J. "Seeing with S cones." Prog Retin Eye Res **20**: 255-287, 2001.

The S cone is highly conserved across mammalian species, sampling the retinal image with less spatial frequency than other cone photoreceptors. In human and monkey retina, the S cone represents typically 5-10% of the cone mosaic and distributes in a quasi-regular fashion over most of the retina. In the fovea, the S cone mosaic recedes from a central "S-free" zone whose size depends on the optics of the eye for a particular primate species: the smaller the eye, the less extreme the blurring of short wavelengths, and the smaller the zone. In the human retina, the density of the S mosaic predicts well the spatial acuity for S-isolating targets across the retina. This acuity is likely supported by a bistratified retinal ganglion cell whose spatial density is about that of the S cone. The dendrites of this cell collect a depolarizing signal from S cones that opposes a summed signal from M and L cones. The source of this depolarizing signal is a specialized circuit that begins with expression of the L- AP4 or mGluR6 glutamate receptor at the S cone-->bipolar cell synapse. The pre-synaptic circuitry of this bistratified ganglion cell is consistent with its S-ON/(M+L)-OFF physiological receptive field and with a role for the ganglion cell in blue/yellow color discrimination. The S cone also provides synapses to other types of retinal circuit that may underlie a contribution to the cortical areas involved with motion discrimination.

Martin, P. R., B. B. Lee, A. J. White, S.G. Solomon, S. G. and L. Ruttiger. "Chromatic sensitivity of ganglion cells in the peripheral primate retina." Nature **410**: 933-936, 200`.

Visual abilities change over the visual field. For example, our ability to detect movement is better in peripheral vision than in foveal vision, but colour discrimination is markedly worse. The deterioration of colour vision has been attributed to reduced colour specificity in cells of the midget, parvocellular (PC) visual pathway in the peripheral retina. We have measured the colour specificity (red-green chromatic modulation sensitivity) of PC cells at eccentricities between 20

and 50 degrees in the macaque retina. Here we show that most peripheral PC cells have red-green modulation sensitivity close to that of foveal PC cells. This result is incompatible with the view that PC pathway cells in peripheral retina make indiscriminate connections ('random wiring') with retinal circuits devoted to different spectral types of cone photoreceptors. We show that selective cone connections can be maintained by dendritic field anisotropy, consistent with the morphology of PC cell dendritic fields in peripheral retina. Our results also imply that postretinal mechanisms contribute to the psychophysically demonstrated deterioration of colour discrimination in the peripheral visual field.

Smith, V. C., J. Pokorny, B. B. Lee, and D. M. Dacey. "Primate horizontal cell dynamics: An analysis of sensitivity regulation in the outer retina." Journal of Neurophysiology **85**: 545-558, 2001.

The human cone visual system maintains sensitivity over a broad range of illumination, from below 1 troland to 1,000,000 trolands. While the cone photoreceptors themselves are an important locus for sensitivity regulation-or light adaptation-the degree to which they contribute in primates remains unclear. To determine the range of sensitivity regulation in the outer retina, the temporal dynamics, neural gain control, and response range compression were measured in second-order neurons, the H1 horizontal cells, of the macaque retina. Situated at the first synapse in the retina, H1 cells receive input from a large population of cones. Lee et al. have previously shown that sensitivity regulation in H1 cells is both cone type-specific and spatially restricted. The sensitivity regulation seen in H1 cells at moderate illuminances thus takes place before the summation of cone signals in these cells, and the data establish the H1 cell as a convenient locus for analyzing cone signals. In the present study, cone-driven responses of primate H1 cells to temporally modulated sine-wave stimuli and to increment pulses were measured at steady levels of 1-1,000 trolands. The H1 cell gave a modulated response to sine-wave stimuli and hyperpolarized to increment pulses with overshoots at stimulus onset and offset. The temporal amplitude sensitivity function was primarily low-pass in shape, with a small degree of low-frequency roll off and a resonance shoulder near 40 Hz. A model incorporating a cascade of first-order filters together with an underdamped second-order filter could describe both temporal sinusoidal and pulse hyperpolarizations. Amplitude sensitivity was estimated from both pulse and sine-wave data as a function of the steady adaptation level. Sensitivity at low light levels (1 troland) showed a slowing in temporal dynamics, indicating time-dependent sensitivity regulation. Sensitivity was reduced at light levels above approximately 10 trolands, reflecting both response range compression and neural gain control. Thus the outer retina is a major locus for sensitivity regulation in primates.

ANATOMY AND PHYSIOLOGY: CORTEX

Johnson, E. N., M. J. Hawken and R. Shapley, "The spatial transformation of color in the primary visual cortex of the macaque monkey." Nat Neurosci **4**: 409-416, 2001.

Perceptually, color is used to discriminate objects by hue and to identify color boundaries. The primate retina and the lateral geniculate nucleus (LGN) have cell populations sensitive to color modulation, but the role of the primary visual cortex (V1) in color signal processing is uncertain. We re-evaluated color processing in V1 by studying single-neuron responses to luminance and to equiluminant color patterns equated for cone contrast. Many neurons respond robustly to both equiluminant color and luminance modulation (color-luminance cells). Also, there are neurons that prefer luminance (luminance cells), and a few neurons that prefer color (color cells). Surprisingly, most color-luminance cells are spatial-frequency tuned, with approximately equal

selectivity for chromatic and achromatic patterns. Therefore, V1 retains the color sensitivity provided by the LGN, and adds spatial selectivity for color boundaries.

Conway, B. R. "Spatial structure of cone inputs to color cells in alert macaque primary visual cortex (V-1)." J Neurosci **21**: 2768-2783, 2001.

The spatial structure of color cell receptive fields is controversial. Here, spots of light that selectively modulate one class of cones (L, M, or S, or loosely red, green, or blue) were flashed in and around the receptive fields of V-1 color cells to map the spatial structure of the cone inputs. The maps generated using these cone-isolating stimuli and an eye-position-corrected reverse correlation technique produced four findings. First, the receptive fields were Double-Opponent, an organization of spatial and chromatic opponency critical for color constancy and color contrast. Optimally stimulating both center and surround subregions with adjacent red and green spots excited the cells more than stimulating a single subregion. Second, red-green cells responded in a luminance-invariant way. For example, red-on-center cells were excited equally by a stimulus that increased L-cone activity (appearing bright red) and by a stimulus that decreased M-cone activity (appearing dark red). This implies that the opponency between L and M is balanced and argues that these cells are encoding a single chromatic axis. Third, most color cells responded to stimuli of all orientations and had circularly symmetric receptive fields. Some cells, however, showed a coarse orientation preference. This was reflected in the receptive fields as oriented Double-Opponent subregions. Fourth, red- green cells often responded to S-cone stimuli. Responses to M- and S- cone stimuli usually aligned, suggesting that these cells might be red- cyan. In summary, red-green (or red-cyan) cells, along with blue-yellow and black-white cells, establish three chromatic axes that are sufficient to describe all of color space.

Engel, S. A. and C. S. Furmanski. "Selective adaptation to color contrast in human primary visual cortex." J Neurosci **21**: 3949-3954, 2001.

How neural activity produces our experience of color is controversial, because key behavioral results remain at odds with existing physiological data. One important, unexplained property of perception is selective adaptation to color contrast. Prolonged viewing of colored patterns reduces the perceived intensity of similarly colored patterns but leaves other patterns relatively unaffected. We measured the neural basis of this effect using functional magnetic resonance imaging. Subjects viewed low-contrast test gratings that were either red-green (equal and opposite long- and middle-wavelength cone contrast, L-M) or light-dark (equal, same-sign, long- and middle-wavelength cone contrast, L+M). The two types of test gratings generated approximately equal amounts of neural activity in primary visual cortex (V1) before adaptation. After exposure to high-contrast L-M stimuli, the L-M test grating generated less activity in V1 than the L+M grating. Similarly, after adaptation to a high-contrast L+M grating, the L+M test grating generated less activity than the L-M test grating. Behavioral measures of adaptation using the same stimuli showed a similar pattern of results. Our data suggest that primary visual cortex contains large populations of color-selective neurons that can independently adjust their responsiveness after adaptation. The activity of these neural populations showed effects of adaptation that closely matched perceptual experience.

CENTRAL DISORDERS

Girkin, C. A. and N. R. Miller "Central disorders of vision in humans." Surv Ophthalmol **45**: 379-405, 200`.

Over the past 20 years, researchers have discovered over 30 separate visual areas in the cortex of the macaque monkey that exhibit specific responses to visual and environmental stimuli. Many of these areas are homologous to regions of the human visual cortex, and numerous syndromes involving these areas are described in the neurologic and ophthalmic literature. The focus of this review is the anatomy and physiology of these higher cortical visual areas, with special emphasis on their relevance to syndromes in humans. The early visual system processes information primarily by way of two separate systems: parvocellular and magnocellular. Thus, even at this early stage, visual information is functionally segregated. We will trace this segregation to downstream areas involved in increasingly complex visual processing and discuss the results of lesions in these areas in humans. An understanding of these areas is important, as many of these patients will first seek the attention of the ophthalmologist, often with vague, poorly defined complaints that may be difficult to specifically define.

Miceli, G., E. Fouch, R. Capasso, et al. "The dissociation of color from form and function knowledge." Nat Neurosci **4**: 662-667, 2001.

We report on two brain-damaged subjects who exhibit the uncommon pattern of loss of object color knowledge, but spared color perception and naming. The subject P.C.O., as in previously reported patients, is also impaired in processing other perceptual and functional properties of objects. I.O.C., in contrast, is the first subject on record to have impaired object color knowledge, but spared knowledge of object form, size and function. This pattern of performance is consistent with the view that semantic information about color and other perceptual properties of objects is grounded in modality-specific systems. Lesion analysis suggests that such grounding requires the integrity of the mesial temporal regions of the left hemisphere.