DALTONIANA

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Daltoniana on the web

Welcome to the 8th 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.

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Officers and Committee

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General Secretary's report

Bonne année et meilleures voeux!

The proceedings from the 1999 Gottingen meeting are out and members should have received or be receiving shortly their copy of the Supplementary issue of Color Research and Application. The Table of Contents can be viewed on the CR&A website at Wiley. This volume gives an excellent overview of the breadth of interests within our society, running from history and art to basic mechanisms and clinical applications. The next meeting in Cambridge is scheduled for July 13-17 and will coincide with the bicentenary of Thomas Young's Bakerian lecture. We have not yet a final idea of how the proceedings will be published but will communicate this information as soon as it is available.

My 4 year term as General Secretary will be up in 2001. It is time to consider nominations for this post as well as for the Board of Directors. Nominations will be accepted at the Business meeting in Cambridge and voting will be by mail ballot, as usual. See you there.

ICVS Meeting 2001
(web page http://www.icvs2001.org.uk/)

Cambridge Symposium, July 2001

The next symposium of the Society will be held in Cambridge, from Friday July 13th to Tuesday July 17th, 2001. The meeting will begin after lunch on July 13th and will end at lunchtime on July 17th. There will be a meeting of the Directorial Committee at 9.30 a.m. on July 13th.

Full details of the meeting were circulated with the last issue of *Daltoniana* and can be found on the conference web site: http://www.icvs2001.org.uk

The meeting will cover all aspects of normal colour vision, as well as inherited and acquired deficiencies of colour vision. Special topics will include the cone dystrophies, the molecular biology of colour vision, and the history of colour theory in the nineteenth century. The Society has always welcomed clinical papers.

The symposium is being held in Cambridge to mark the bicentennial of Thomas Young's Bakerian Lecture of 1801, in which he developed the wave theory of light and introduced the trichromatic theory of colour vision in its modern form. Thomas Young was a Fellow of Emmanuel College, Cambridge, and College legend holds that he first observed wave interference in patterns of radiating ripples in the pond in the Fellows' Garden.

Accommodation for the meeting is available in Peterhouse, the oldest college of the University. This is pleasant accommodation in student rooms at a cost of £31 per night. Accommodation in Peterhouse can be booked through the organisers at the same time as registering. The rooms in Peterhouse are for single occupancy, and children under 14 are not

allowed in the College. Our web site offers a variety of alternative accommodation in guest houses and hotels, which should be booked independently of the conference organisers. We recommend reserving your accommodation early and with circumspection, since July is high season in Cambridge and hotels are in a sellers' market.

As is the tradition of the International Colour Vision Society, there will be a single inclusive registration fee, to cover the scientific sessions, three lunches, three dinners, refreshments throughout the meeting, and an excursion. Until March 1, the registration fees are less:

	Until March 1	After March 1
Standard:	£165	£200
Pre-doctoral student:	£130	£165
Accompanying person:	£115	£150

The registration fee for accompanying persons covers the receptions, three dinners and the excursion. After March 1 the standard registration fee will be £200 and the other fees will increase proportionately. Owing to the limited size of the lecture theatre and the Society's desire to retain the traditional character of its meetings, the total number of registrants will be 120. The Directorial Committee has determined that preference should be given to those who were paid-up members of the Society on January 1, 2001.

A copy of the registration form is enclosed with this mailing or may be downloaded from http://orlab.optom.unsw.edu.au/icvs/icvs.registration.pdf

The Social Programme will include the following events:

- *Friday evening:* Private reception in the Fitzwilliam Museum and an introduction to Rennaissance Colourists by the Director, Duncan Robinson.
- *Saturday evening:* Garden party in Emmanuel College, beside the pond in which Thomas Young observed the interference of waves.
- *Sunday afternoon:* Excursion
- *Monday evening:* Private reception at No. 1 Trinity Street, which has been in continuous use as a bookshop since 1581, longer than any other in the world.

The deadline for submission of abstracts is April 2nd. Earlier submission is welcomed.

Travel information is available on our web site. For those travelling from overseas, we strongly recommend flying to Cambridge or to London Stansted airports. Amsterdam serves as the hub airport for Cambridge, while Stansted has cheap flights from many parts of Europe. It may be worth travelling a little further in your own country and then flying direct to Stansted, rather than taking a more obvious route through London Heathrow. London Gatwick lies well to the south of London and is overcrowded in July: do not even think of flying from a European city to London Gatwick merely to save a little money on the flight.

The Organising Committee for the symposium consists of Professor J. D. Mollon, Dr. B. C. Regan, Dr. A. Shapiro, Dr. M. Simunovic, Dr. M. V. Danilova, Mary Hood and Christoph Zrenner. We look forward to welcoming you to Cambridge in July.

Enquiries about the meeting should be directed to Professor J. D. Mollon, Department of Experimental Psychology, University of Cambridge, Downing Street, Cambridge CB2 3EB, United Kingdom.

Abstracts of color vision papers. Compiled by Joel Pokorny

MOLECULAR GENETICS

Oda, S. Ueyama, H. Tanabe, S. Tanaka, Y. Yamade, S. Kani, K. Detection of female carriers of congenital color-vision deficiencies by visual pigment gene analysis. Curr Eye Res 21: 767-773, 2000

PURPOSE. Congenital color-vision deficiencies are frequent among males, 4.7-8.0%, suggesting that female carriers are present at a frequency of 9-15%. The purpose of this study was to determine whether carriers could be detected by analysis of the visual pigment genes. METHODS. DNA from 29 males with congenital color-vision deficiencies, from their mothers, and from 117 randomly-selected females was analyzed. The most upstream genes, the downstream genes, and the most downstream genes in the red/green pigment gene arrays were amplified separately by PCR. Exon 5 of each gene was analyzed by single-strand conformation polymorphisms (SSCP). RESULTS. Analysis of the visual pigment genes suggests that one of the 29 mothers examined is a female protan and two others are carriers of both protan and deutan defects. The remaining 26 mothers were confirmed to be carriers of congenital color-vision deficiencies. Unusual patterns were observed in 15 (13%) of the randomly-selected females; among them, 5 appeared to be protan carriers and at least 4 to be deutan carriers. CONCLUSIONS. Female carriers of congenital color-vision deficiencies can be detected by analysis of the visual pigment genes. Since the proportion of females showing unusual patterns was slightly higher than expected, some must be false- positives and require more detailed examination.

Ayyagari, R. Kakuk, L. E. Bingham, E. L. Szczesny, J. J. Kemp, J. Toda, Y. Felius, J. Sieving, P. A. Spectrum of color gene deletions and phenotype in patients with blue cone monochromacy. Hum Genet 107: 75-82, 2000

Blue cone monochromacy (BCM) is an X-linked ocular disease characterized by poor visual acuity, nystagmus, and photodysphoria in males with severely reduced color discrimination. Deletions, rearrangements and point mutations in the red and green pigment genes have been implicated in causing BCM. We assessed the spectrum of genetic alterations in ten families with BCM by Southern blot, polymerase chain reaction, and sequencing analysis, and the phenotype was characterized by ophthalmoscopy, fluorescein angiography, and a battery of tests to assess color vision in addition to routine ophthalmological examination. All families showed clinical features associated with BCM. Acuities were reduced in all affected males, and photopic b-wave was reduced by more than 90% in seven families. In three families, however, the photopic b-wave response showed uncharacteristic relative preservation of 30-80% (of the clinical low- normal value). The color vision was unusually preserved in two affected males, but this was not correlated with photopic electroretinography retention. Progressive macular atrophy was observed in affected members of two BCM families while the rest of the families presented with normal fundus. In nine families deletions were identified in the gene encoding the red-sensitive photopigment and/or in the region up to 17.8 kb upstream of the red gene which contains the locus control region and other regulatory sequences. In the same nine families the red pigment gene showed a range of deletions from the loss of a single exon to loss of the complete red gene. In one family no mutation was found in the exons of the red gene or the locus control region but showed loss of the complete green gene. No association was observed between the phenotypes and genotypes in these families.

Sundin, O. H. Yang, J. M. Li, Y. Zhu, D. Hurd, J. N. Mitchell, T. N. Silva, E. D. Maumenee, I. H. Genetic basis of total colourblindness among the Pingelapese islanders. Nat Genet 25: 289-293, 2000

Complete achromatopsia is a rare, autosomal recessive disorder characterized by photophobia, low visual acuity,

nystagmus and a total inability to distinguish colours. In this disease, cone photoreceptors, the retinal sensory neurons mediating colour vision, seem viable but fail to generate an electrical response to light. Achromatopsia, or rod monochromatism, was first mapped to 2p11-2q12 (MIM 216900; ref. 3), where it is associated with missense mutations in CNGA3 (ref. 4). CNGA3 encodes the alpha-subunit of the cone cyclic nucleotide-gated cation channel, which generates the light-evoked electrical responses of cone photoreceptors. A second locus at 8q21-q22 has been identified among the Pingelapese islanders of Micronesia, who have a high incidence of recessive achromatopsia (MIM 262300). Here we narrow the achromatopsia locus to 1.4 cM and show that Pingelapese achromatopsia segregates with a missense mutation at a highly conserved site in CNGB3, a new gene that encodes the beta-subunit of the cone cyclic nucleotide-gated cation channel. Two independent frameshift deletions establish that achromatopsia is the null phenotype of CNGB3. Combined with earlier findings, our results demonstrate that both alpha- and beta-subunits of the cGMP-gated channel are essential for phototransduction in all three classes of cones.

ANATOMY AND PHYSIOLOGY

De Valois, R. L. Cottaris, N. P. Elfar, S. D. Mahon, L. E. Wilson, J. A. Some transformations of color information from lateral geniculate nucleus to striate cortex. Proc Natl Acad Sci U S A 97: 9 4997-5002, 2000

We have recorded the responses of single cells in the lateral geniculate nucleus (LGN) and striate cortex of the macaque monkey. The response characteristics of neurons at these successive visual processing levels were examined with isoluminant gratings, cone- isolating gratings, and luminance-varying gratings. The main findings were: (i) Whereas almost all parvo- and konio-cellular LGN cells are of just two opponent-cell types, either differencing the L and M cones (L(o) and M(o) cells), or the S vs. L + M cones (S(o) cells), relatively few striate cortex simple cells show chromatic responses along these two cardinal LGN axes. Rather, most are shifted away from these LGN chromatic axes as a result of combining the outputs (or the transformed outputs) of S(o) with those of L(o) and/or M(o) cells. (ii) LGN cells on average process color information linearly, exhibiting sinusoidal changes in firing rate to isoluminant stimuli that vary sinusoidally in cone contrast as a function of color angle. Some striate cortex simple cells also give linear responses, but most show an expansive response nonlinearity, resulting in narrower chromatic tuning on average at this level. (iii) There are many more +S(o) than - S(o) LGN cells, but at the striate cortex level -S(o) input to simple cells is as common as +S(o) input. (iv) Overall, the contribution of the S-opponent path is doubled at the level of the striate cortex, relative to that at the LGN.

PSYCHOPHYSICS

Pearson, P. M. Swanson, W. H. Chromatic contrast sensitivity: the role of absolute threshold and gain constant in differences between the fovea and the periphery. J Opt Soc Am A 17: 232-243, 2000

A model of foveal achromatic and chromatic sensitivity [Vision Res. 36, 1597 (1996)] was extended to the peripheral visual field. Threshold- versus-illuminance functions were analyzed to determine effects of eccentricity on absolute thresholds and gain constants of chromatic and luminance mechanisms. The resulting peripheral model successfully predicted peripheral contrast sensitivity as a function of wavelength, for both white and 500-nm backgrounds. We conclude that the short- wavelength-sensitive cone opponent mechanism may mediate thresholds in Sloan's notch in the normal periphery and that interpretation of reduced chromatic sensitivity in the periphery requires an explicit model of how eccentricity affects both the gain constant and the absolute threshold.

Lehky, S. R. Deficits in visual feature binding under isoluminant conditions. J Cogn Neurosci 12: 383-392, 2000

The contribution of the magnocellular stream to visual feature binding was examined psychophysically through the use of isoluminant stimuli. Subjects were presented with three briefly flashed colored letters arranged in an array and asked to identify the shape and color of the center letter. The rate of illusory conjunctions was much higher when the letters were isoluminant with a gray background, compared to when the letters were either brighter or dimmer. Over 90% of conjunction errors involved pairing the wrong shape with the correct color, rather than vice versa. Directing attention to the target location with a nonisoluminant cue did not reduce illusory conjunctions. High rates of binding errors under isoluminance are interpreted here in terms of abnormalities in visual form processing rather than an attentional effect. In another experiment designed to examine the role of synchrony in feature binding, the rate of illusory conjunctions was highest when flanking letters were presented before the central target letter and

not synchronously.

Garcia, J. A. Nieves, J. L. Valero, E. Romero, J. Stochastic independence of color-vision mechanisms confirmed by a subthreshold summation paradigm. J Opt Soc Am A 17: 1485-1458, 2000

We have used a subthreshold summation protocol to analyze spatial color- color interaction. By means of a CRT color monitor, we measured the threshold contours for a spatial frequency of 0.5 cycles/degree. Heterochromatic flicker photometry was used to obtain isoluminance. The results suggest that the blue-yellow (b-y) and red-green (r-g) contrast thresholds remained unchanged by the addition of fixed r-g and b-y subthreshold pedestals. Our subthreshold summation data then support the stochastic independence of colorvision mechanisms derived from Mullen and Sankeralli's work [Vision Res. 39, 733 (1999)] despite the differences that exist between the two experimental methods.

Schirillo, J. A. Shevell, S. K. Role of perceptual organization in chromatic induction. J Opt Soc Am A 17: 244-254, 2000

Color matches between two small patches were made in a display containing ten larger regions of different chromaticities. The spatial organization of the ten regions was varied while keeping constant the immediate surround of each patch as well as the space-average chromaticity of the entire stimulus. Different spatial arrangements were designed to alter the perceptual organization inferred by the observer without changing the ensemble of chromaticities actually in view. For example, one arrangement of the ten regions was consistent with five surfaces under two distinct illuminations, with one edge within the display (an "apparent illumination edge") dividing the stimulus into two areas, one under illuminant A and the other under illuminant C. Another spatial arrangement had the ten regions configured to induce an observer to infer ten surfaces under a single illumination. When the ten regions were arranged with an apparent illumination edge, the patch within the area of illuminant C was perceived as bluer than when the same patch and immediate surround were presented without an apparent illumination edge. The results are accounted for by positing that observers group together regions sharing the same inferred illumination, with a consequent effect on color perception: A fixed patch-within-surround shifts in hue and saturation toward the perceived illumination. We suggest that the change in color perception in a complex scene that results from a difference in real illumination may be caused by the inferred illumination at the perceptual level, not directly by the physical change in the light absorbed by photoreceptors.

Moutoussis, K. Zeki, S. A psychophysical dissection of the brain sites involved in color- generating comparisons. Proc Natl Acad Sci U S A 97: 8069-8074, 2000

We have used simple psychophysical methods to determine the sites of color-generating mechanisms in the brain. In our first experiment, subjects viewed an abstract multicolored "Mondrian" display through one eye and an isolated patch from the display through the other. With normal binocular/monocular viewing, the patch has a different color when viewed on its own (void mode) or as part of the Mondrian display (natural mode) [Land, E. H. (1974) Proc. R. Inst. G. B. 49, 23-58]. When the two stimuli were viewed dichoptically, with the patch occupying the position that it would occupy in the Mondrian complex under normal viewing, the patch always appeared in its void color. In a second experiment, when subjects viewed multicolored displays through a different narrow-band filter placed over each eye, the information from the two eyes was combined to result in new colors, which were not seen through either of the two eyes alone. Taken together, these results dissect color-generating mechanisms into two stages, located at different sites of the brain: The first occurs before the appearance of binocular neurons in the cortex and compares wavelength information across space, whereas the second occurs after the convergence of the input from the two eyes and synthetically combines the results of the first.

Webster, M. A. Malkoc, G. Color-luminance relationships and the McCollough effect. Percept Psychophys 62: 659-672, 2000

The McCollough effect is an orientation-specific color aftereffect induced by adapting to colored gratings. We examined how the McCollough effect depends on the relationships between color and luminance within the inducing and test gratings and compared the aftereffects to the color changes predicted from selective adaptation to different color- luminance combinations. Our results suggest that the important contingency underlying the McCollough effect is between orientation and color-luminance direction and are consistent with sensitivity changes within mechanisms tuned to specific color-luminance directions. Aftereffects are similar in magnitude for adapting color

pairs that differ only in S cone excitation or L and M cone excitation, and they have a similar dependence on spatial frequency. In particular, orientation-specific aftereffects are induced for S cone colors even when the grating frequencies are above the S cone resolution limit. Thus, the McCollough effect persists even when different cone classes encode the orientation and color of the gratings.

CLINICAL STUDIES AND TESTING

Cho, N. C. Poulsen, G. L. Ver Hoeve, J. N. Nork, T. M. Selective loss of S-cones in diabetic retinopathy. Arch Ophthalmol 118: 1393-1400, 2000

OBJECTIVE: To determine whether selective cone loss could explain the acquired tritan-like color confusion found in diabetic retinopathy. METHODS: Terminal deoxynucleotidyl transferase-mediated biotin- deoxyuridine triphosphate nick end labeling (TUNEL) was employed on paraffin sections of retinas from 5 donors with diabetic retinopathy. For quantitative analysis, postmortem retinas were obtained from 13 human donors; 7 from patients with various durations and stages of diabetic retinopathy (4 background, 3 proliferative) and 6 controls. Enzyme histochemical analysis for carbonic anhydrase (CA) was used to distinguish L/M-cones (positive for CA) from S-cones (negative for CA). Cone topography was determined by sampling 360 degrees from 0.1 to 1.5 mm of foveal eccentricity and along the horizontal meridians from 1.5 to 15.0 mm. RESULTS: Rare cells in both the inner and outer nuclear layers of the diabetic eyes were positively labeled with the TUNEL method. The CA staining revealed incomplete and patchy losses of S- cones that were limited to the diabetic retinas. Statistically significant reduction in the density of S-cones was found at nearly all foveal eccentricities from 0.1 mm to 15.0 mm. This was not the case for the L/M-cones. On average, for all locations, the percentage of S-cones compared with L/M-cones was decreased by 21.0% +/- 3.4% with respect to the controls. CONCLUSION: The S-cones selectively die in diabetic retinopathy. CLINICAL RELEVANCE: Selective loss of S-cones may contribute to the tritan-like color vision deficit seen in patients with diabetic retinopathy.

TOXICITIES Gobba, F. Color vision: a sensitive indicator of exposure to neurotoxins. Neurotoxicology 21: 857-862, 2000

In the last 15 years an increasing number of studies have investigated color discrimination in workers exposed to various neurotoxins. Color vision was generally evaluated using the Lanthony D-15 desaturated panel (D-15 d), a test suited to identify mild acquired impairments, that can be easily performed at the workplace. In most studies, results were quantitatively expressed using the method of Bowman or that of Vingrys and King-Smith: the former is the most widely reported, while the latter gives information on the type of color defect. Applying D-15 d, or other color perception tests, impairment in color vision was observed among workers exposed to several solvents (styrene, perchloroethylene, toluene, n-hexane, and carbon disulfide), or to solvent mixtures, and also to metals like mercury. Chemical related color vision loss is a sub-clinical early effect, and in most studies proved dose-related. For styrene and perchloroethylene, and also for solvent mixtures, an impairment was observed at exposure levels lower than the current occupational limits, suggesting that these limits may be inadequate for a proper protection of visual function of workers.

Maar, N. Tittl, M. Stur, M. Zajic, B. Reitner, A. A new colour vision arrangement test to detect functional changes in diabetic macular oedema. Br J Ophthalmol 85: 47-51, 2001

AIM: A study was undertaken to investigate the correlation between colour discrimination tests and the presence of macular oedema in patients with type I diabetes to find a sensitive diagnostic tool for the detection of early functional changes. METHODS: The study was performed in 39 type I diabetic patients, 10 with and 29 without macular oedema. The examination included biomicroscopy, fundus photography of the macula, videofluorescein angiography, the LogMAR visual acuity chart, Farnsworth-Lanthony desaturated D-15 test, and the new Mollon-Reffin "Minimalist" test for colour vision deficiencies version 6.0. RESULTS: A highly significant correlation was found between the tritan value of the Mollon test and the presence of clinically significant macular oedema (p0.0015), with a high sensitivity (88.9%) and specificity (93.3%). The DD-15 test was not significant (p=0.345) and showed low sensitivity for the presence of macular oedema (36%). All variables concerning the grading of macular oedema showed a highly significant association with the tritan values of the Mollon test (p0.0001). CONCLUSION: The results suggest that the Mollon-Reffin "Minimalist" test version 6.0 is the best colour discrimination test for detecting macular oedema, with higher specificity and sensitivity than the other methods used in the study.

Maaranen, T. H. Tuppurainen, K. T. Mantyjarvi, M. I. Color vision defects after central serous chorioretinopathy. Retina 20: 633-637, 2000

PURPOSE: To reexamine patients diagnosed with central serous chorioretinopathy (CSC) during the 10-year period from 1987 to 1996 to identify remaining color vision defects in the eyes with normal visual acuity (VA). METHODS: Thirty-nine patients were found with normal VA of 20/20 (logMAR 0) or better 8 to 166 months (mean +/- SD, 58.8 +/- 41.2) after active CSC. Color vision was examined with the Standard Pseudoisochromatic Plates part 2, Farnsworth-Munsell 100 hue test, and Color Vision Meter 712 anomaloscope. RESULTS: Of the CSC eyes, 26 (67%) had a color vision defect, most of them in the blue area. There was no correlation between the time since the active disease and the results on the color vision tests. Of the contralateral eyes, 19 (49%) also had a color vision defect. CONCLUSION: In many patients some degree of color vision defect remains after CSC even if the VA has recovered to normal. The contralateral eye can also have a color vision defect. This has not been previously reported and might be due to earlier subclinical CSC.

Nishio, Y. Kandatsu, A. [The Rayleigh color matches in idiopathic macular holes treated by vitrectomy]. Nippon Ganka Gakkai Zasshi 104: 232-236, 2000

PURPOSE: The Rayleigh color matches were measured to investigate the optical density in the cone photopigment of the central retina in patients with macular holes that had closed after vitrectomy. METHODS: The Rayleigh equation was measured with the IF-2 anomaloscope in 7 patients with macular holes in one eye, that had closed after vitrectomy and gained an improvement in visual acuity of 0.5 or better. Reductions in the pigment optical density of cone photoreceptors of the opposite eyes were estimated with Rayleigh equations obtained in this experiment. RESULT: The Rayleigh equations of the affected eyes were shifted toward protanomalous setting compared with that of the opposite eyes. The optical densities of cone photoreceptors of the affected eyes were lower than those in the opposite eyes, even in patients with visual acuity of 1.0 or better. CONCLUSION: These findings suggest that the recovery of the visual acuity may precede that of the optical density in cone photopigment of central retina. The Rayleigh equation is more sensitive than visual acuity for evaluating visual function after vitrectomy for macular holes.

Semple, S. Dick, F. Osborne, A. Cherrie, J. W. Soutar, A. Seaton, A. Haites, N. Impairment of colour vision in workers exposed to organic solvents. Occup Environ Med 57: 582-587, 2000

OBJECTIVES: To investigate loss of colour vision related to exposure to solvents and the role of three enzyme polymorphisms in modifying the risk in exposed workers. METHODS: A sample was studied of 68 male dockyard workers and 42 male community controls with and without neuropsychological symptoms from a previous cross sectional study. Indices of cumulative and intensity based exposure to solvents were calculated for all subjects. Alcohol, drug, and smoking histories were obtained. Colour vision was tested by Lanthony D15d colour vision test. Genotype of glutathione S-transferase M1 and T1 and N-acetyltransferase 2 polymorphisms were determined. RESULTS: The relation between impairment of colour vision and exposure to solvents was investigated with multiple regression techniques. Increasing annual exposure to solvents was significantly associated with reduced colour vision ($p=0.029$). Impairment of colour vision was not associated with neuropsychological symptoms as measured by the Q16 solvent symptom questionnaire. No significant association was found between acquired impairment of colour vision and genetic polymorphisms when GSTM1, GSTT1 or NAT2 phenotypes were included in the analyses. CONCLUSIONS: Exposure to mixed solvents is associated with impairment in colour vision, the risk increases with increasing exposure. The risk of impairment of colour vision was not altered in this study by the presence of different GSTM1, GSTT1 or NAT2 polymorphisms.