vision

Bulletin of the Applied Vision Association

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APPLIED VISION ASSOCIATION

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AIM OF THE AVA: TO PROMOTE AND ADVANCE THE APPLICATION OF RESEARCH WORK IN ALL AREAS RELATED TO VISION

Noticeboard

AVA on the World Wide Web

The Applied Vision Association now has its own world wide web pages at:

http://www.dmu.ac.uk/ava/

The pages contain details of who is on the committee, contact emails, latest details on forthcoming AVA meetings and links to other vision related pages. There are also archives of abstracts from previous AVA meetings.

AVA and OPO Subscriptions

Membership for 1997/1998 will be the same price as last year (but is likely to increase in the following year. Those members who pay by standing order for the AVA and Ophthalmic and Physiological Optics please check that the correct amount is being paid to the AVA.

Editorial

This issue of the Bulletin of the AVA contains an obituary of W.D. Wright, reprinted with permission from the Colour Group Newsletter. In September there will be a meeting on depth perception at the University of Surrey. This meeting has been organised by Dr Mark Bradshaw and the meeting timetable and abstracts are printed in this issue. In November there will be a scientific meeting at the College of Optometrists designed for postgraduates wishing to present work in progress. Finally, in this issue Steve Westland from Keele University has written a book review of the “Dalton” conference.

If you have any comments on the Bulletin of the AVA then do contact me: mscase@dmu.ac.uk

Deadline for copy for the next Bulletin - 16th October 1997

Geoffrey J. Burton Memorial Fund

The fund was established in 1986 with the aim of providing financial assistance to students (in non-established or fixed term posts) based in the UK travelling to any conferences or meetings at which they will be presenting a paper or poster. Donations to the fund can be directed to the AVA secretariat and cheques etc. should be made payable to “The Geoffrey J. Burton Memorial Fund”.

The maximum award to any one individual is £200.

Awards can be made for any conference in the calendar year in which the award falls (1998 in this case). You do not have to be presenting at an AVA conference. The awards will be made twice a year.

The next closing dates for applications are:

28th February 1998
31st August 1998

To apply for an award you need to complete an application form which is available from:

The AVA Secretariat,
College of Optometrists,
10 Knaresborough Place,
London,
SW5 0TG.

W DAVID WRIGHT OBITUARY

The name of W. David Wright is famous the world over in the field of colorimetry. In the late nineteen-twenties he measured, for ten observers, the way in which the colours of the spectrum are matched by beams of red, green, and blue light added together. This work, together with a similar study carried out by John Guild at the National Physical Laboratory, with seven additional observers, forms the basis of the international standard for measuring colour. It is a great tribute to the quality of this experimental work that the standard, although now more than sixty years old, is still in universal use.

David Wright carried out his work in the Physics department of Imperial College, and, except for a short interlude from 1929 to 1930, the whole of his career was at Imperial. The interlude was spent as a research engineer at Westinghouse Electric and Manufacturing Company, in Pittsburg, where he worked on colour television; this was long before even black-and-white television was a practicality, but the colour television systems in use today use Wright's work as the basis of their reproduction of colour by the addition of areas of red, green, and blue light.

Wright's researches at Imperial College covered many aspects of colour vision, and were summarized in his book *Researches on Normal and Defective Colour Vision* published in 1946, one of five books which he wrote. The same meticulous care in his experimental work that had characterized his original colour matching experiments, was evident throughout all his investigations, and led, for the first time, to definitive descriptions of the main types of colour blindness. The publication in the magazine *Picture, Post* of a test for a very rare type of colour deficiency, in which bluish and yellowish colours are confused, led to the discovery of about a score of people with this defect, and the characteristics of their vision were documented accurately for the first time.

As a professor at Imperial College, he was both a fine lecturer and an outstanding supervisor of post-graduate students. There issued from the college during his tenure, a continuous stream of students who were thoroughly grounded in visual science and sound experimental procedures; today, at any conference on colour science, many of his past students are to be found presenting work which owes its inspiration to his influence.

His work outside academia was broad and notable. Seeing the need for workers in colour science to have a forum for regular meetings, he was largely instrumental in the formation in 1940 of a Colour Group in the Physical Society, and this Group still flourishes although now as an independent entity. Following the example of the British Colour Group, similar groups have since sprung up in many other countries, and together form the International Colour Association.

He was Chairman of the Colour Group from 1941 to 1943 and again from 1973 to 1975, he was Vice-President of the Physical Society from 1948 to 1950, Secretary of the International Commission for Optics from 1953 to 1966, Chairman of the Physical Society Optical Group from 1956 to 1959, and President of the International Colour Association from 1967 to 1969.

He received honorary Doctorates of Science from City University in 1971 and from the University of Waterloo, Canada, in 1991. He gave the Physical Society Thomas Young Oration in 1951. He received the Newton Medal from the Colour Group in 1963, the AIC Judd gold medal from the International Colour Association in 1977, and recently the Godlove award from the Inter-Society Color Council of the U.S.A.

A keen admirer of paintings, he combined this interest with his colour science to conduct a series of measurements on paintings at the National Gallery to provide data on the permanence of some of its treasures.

He was a passionate follower of cricket and thoroughly enjoyed a day out at Lord's.

In 1932 he married Dorothy Hudson, who died in 1990; they had two sons, one of whom predeceased him.

David sowed the seed of interest for so many of us in colour science today. He was warm hearted and of a kindly disposition. He will be sadly missed by us all. We will honour his memory, remembering his great contributions to colour science and the friendliness and warmth of his character.

Robert W.G. Hunt
Reproduced with permission from the Colour Group Newsletter

Call for papers

Applied Vision Association Postgraduate Meeting.

5th November 1997,
College of Optometrists,
London.

There will be a meeting for postgraduates and researchers up to one year postdoctoral to present papers at the College of Optometrists.

The purpose of this meeting is to give postgraduates an opportunity to present research (not necessarily complete) in a friendly, non-hostile atmosphere.

Please send abstracts of papers you wish to present (250 words maximum) to:

AVA Secretariat,
College of Optometrists,
10 Knaresborough Place,
London,
SW5 0TG.

Registration costs will be kept to a minimum to allow even the poorest postgraduate to attend!

For more information contact the AVA Secretariat on: 0171 373 7765

AVA books for sale

The AVA still has a number of new books for sale from conferences that it has organised over the years.

Payment can be by cheque or postal order in UK pounds (sorry, no credit cards) to “Applied Vision Association”. Send your payment with the order to:

AVA Secretariat,
Applied Vision Association,
College of Optometrists,
10 Knaresborough Place,
London SW5 OTG.

Books available:

The cost for each book is £15 (including postage in the UK) for AVA members or £20 for non-AVA members. If you are outside the UK then add £5 per book to each of the prices above.

Gale, A.S., Astley, S.M., Dance, D.R. and Cairns, A.Y. (1994) **Digital Mammography**. Elsevier (424 pages).

Gale, A.S., Freeman, M.H., Haslegrave, C.M., Smith, P. and Taylor, S.P. (1988) **Vision in Vehicles II**. North Holland (420 pages).

Gale, A.S., Brown, I.D., Haslegrave, C.M., Kruysse, H.W. and Taylor, S.P. (1993) **Vision in Vehicles IV**. North Holland (355 pages).

Brogan, D., Gale, A. and Carr, K. (1993) **Visual Search 2**. Taylor and Francis (477 pages).

The cost of the Dalton conference book is £43 (including postage in the UK) for AVA members or £48 for non-AVA members. If you are outside the UK then add £5 per book.

Dickinson, C., Murray, I. and Carden, D. (1996) **John Dalton’s Colour Vision Legacy**. Taylor and Francis (784 pages).

Book Review

John Dalton's Colour Vision Legacy

Ed. Christine Dickinson, Ian Murray and David Carden

1997 Taylor & Francis, Manchester
ISBN 0748403108 £59.50 (hardback, 738pp)

In his first paper to the Manchester Literary and Philosophical Society, on 31 October 1794, John Dalton analysed his own colour vision deficiency. Exactly 200 years later a meeting was held in Manchester to commemorate Dalton's contribution to colour science; this book contains a total of 77 selected papers from that conference. The papers are organised into ten sections dealing in turn with Dalton's colour vision, pigments and genetics, pathways and channels, spatial and temporal aspects of colour vision, development and colour vision defects, techniques in colour visual testing, colour categories, colour constancy, models of colour vision, and colour applications.

The section on Dalton's colour vision contains two extraordinary contributions from Dalton himself; firstly, extracts of a letter to his cousin where by he describes his own colour experience, and secondly, the reproduction (courtesy of the Manchester Literary and Philosophical Society) of a paper that was first published in 1798. The latter includes an account of Dalton's own vision, an account of others whose vision he found similar to his own, and observations on the probable cause of his anomalous vision. These two contributions are complimented by a paper (Mollon, Dulai, and Hunt) describing recent work on DNA sequencing on samples from one of Dalton's eyes (carefully preserved since his death) which confirms that John Dalton was a dichromat but also that, contrary to previous interpretations, he was a deuteranope with a single LW opsin gene coding for a LW visual pigment.

The papers in the other nine sections are generally of an equally high standard. The range of topics represented is quite impressive and the sections on spatial and temporal aspects of colour vision, colour constancy, and models of colour vision are particularly well represented. To give some idea of the range of topics covered, selected papers include The Development of Colour Vision in Infants (Teller), On the Nature of Unique Hues (Mollon and Jordan), A Model of Spatial and Chromatic Processing in Early Vision (Moorhead), and A Neurocomputational Model for Colour Constancy (Usui and Nakauchi). The weakest section is perhaps that which deals with colour applications; this is a book about colour vision and the applications section gives the impression of having been tagged onto the end of the proceedings, whereas the growing field of colour applications could justify a volume like this one in its own right.

The extensive list of contributors and conference participants is testament to the fact that most colour vision researchers will already know about the Dalton conference and this volume of selected papers. If the goal of the editors was to provide a reasonably comprehensive snapshot of colour vision research today then I think that they have indeed succeeded. This is not a book that will be read from cover to cover but rather provides a unique collection of papers that would compliment any colour scientist's library.

The price of £59.50 is a little excessive but can at least be partly justified by the quality of the production which is extremely high, both in terms of the physical reproduction (hardback cover and some colour plates) and the editorship (the papers have been edited to a common format).

Stephen Westland
Human and Machine Perception Research Centre
Department of Communication and Neuroscience
Keele University

Applied Vision Association Meeting

4th September 1997
DEPTH PERCEPTION
(Physiology and Psychophysics)

Programme

Applied Vision Association will be holding a special 1-Day Conference/ Workshop on DEPTH PERCEPTION (Physiology and Psychophysics) September 4th 1997 at the Department of Psychology, University of Surrey, Guildford, UK.

Invited speakers:
Prof. A.J. Parker / Dr B.G Cumming,
Physiology Laboratory, University of Oxford.
Prof B.J. Rogers
Experimental Psychology, University of Oxford.
Prof. B.J. Gillam
Psychology Department, University of NSW, Australia

Paper Presentations

10.00 Registration and Coffee

10.30 The critical factors determining the strength of the stereoscopic slant response. Barbara Gillam

11.00 A curious illusion suggests complex interactions in depth perception. Mark Mon-Williams and James R. Tresilian

11.15 Coarse to fine - cyclopean processing. Ariella V. Popple and John M. Findlay.

11.30 Stereo masking reveals spatial-frequency channels. Simon Prince and Richard Eagle.

11.45 The minimum contrast requirements for stereopsis. David R. Simmons.

12.00 Dissociating the what and where of stereopsis. Barton L. Anderson.

12.15 Buffet lunch - Minstrels Gallery, Wates House

13.30 Binocular stereopsis: the role of vertical disparities. Brian J. Rogers.

14.00 Perceived depth and retinal disparities. David Heeley.

14.15 Effects of surface orientation and number of surfaces on perceived slant in a 3D scene. George J. Andersen, Myron L. Braunstein and Asad Saidpour.

14.30 Cues to viewing distance for stereoscopic depth constancy. Andrew Glennerster, Brian J. Rogers and Mark F. Bradshaw.

14.45 A curvature contrast effect for stereoscopically-defined surfaces. Susan F. te Pas, Brian J. Rogers and Tim Ledgeway

15.00 Posters

16.00 The relationship between depth perception and neural activity in primary visual cortex. Bruce G. Cumming and Andrew J. Parker.

16.30 Is global motion processing tuned for binocular disparity? Paul B. Hibbard, Mark F. Bradshaw and Bart DeBruyn.

16.45 The recovery of structure from motion under perspective and orthographic projection. Richard A. Eagle and Maarten Hogervorst.

17.00 Using multiple sources of information about relative distances between three collinear dots rotating in a slanted plane. Johan Wagemans and S. Tibau.

17.15 Grasping the impossible: estimating time to contact from monocular and binocular parameters. John Wann and Simon Rushton.

17.30 Posters

Poster Presentations

Temporal characteristics of stereoscopic slant perception. R.S. Allison, I.P. Howard, B.J. Rogers, and H. Bridge.

Uncoupling binocular disparity from relative luminance and relative size in stereoscopic displays. Peter Banton and Peter Thompson.

The interaction of binocular disparity and motion parallax in determining perceived depth and perceived size with natural viewing: is the same estimate of d' used? Mark F. Bradshaw, Andrew D. Parton and Richard A. Eagle.

Systematic Perceptual Distortion of the Normal to a Plane may be Explained by Errors in Perceived Viewing Distance. Philip A. Duke, John P. Frisby, John Porrill, David Buckley.

Visual processing deficits and dyslexia. John Everatt, Mark F Bradshaw, Paul B Hibbard & Martin Lages.

Does temporal delay affect open-loop pointing in adults and children? Joanna Graham Mark F. Bradshaw and Alyson M. Davis.

The effects of eccentricity, vergence angle and elevation upon the relative tilt of corresponding vertical and horizontal meridia revealed using the minimum motion paradigm. Tim Ledgeway and Brian J. Rogers

Biases in perceived structure from motion explained by a Bayesian model. Maarten Hogervorst and Richard A. Eagle.

When texture is a stronger depth cue than motion. Justin O'Brien and Alan Johnston.

Perception and measurement of surface orientation. Pascal Mamassian, Michael S. Landy, and Laurence T. Maloney.

A comparison of binocular and monocular detection of sinewave gratings in two-dimensional noise. S. Pardhan and D. Rose

Is eye of origin labelled? David Rose.

Stereoscopic depth cues can segment motion information. Robert J. Snowden and Melissa Rossiter.

Stereo depth perception from linear combination of first and second-order disparities. Alison K. Statham and Mark A. Georgeson.

The effects of stereoscopic depth upon illusory pausing in random dot patterns. Tim Walpole and Michael J.Wright.

Why do cars hit children?: dismissing the role of relative size in driver judgements of depth. John Wann, Simon Rushton and Christine Caldwell.

Range effects in the psychophysical determination of contrast thresholds for stereopsis. Alison T. Wells and David R. Simmons.

Further information can be obtained from:
Dr M.F. Bradshaw,
Psychology Department,
University of Surrey,
Guildford
GU2 5XH, U.K.

http://www.dmu.ac.uk/ava/meetings.html

email: M.Bradshaw@surrey.ac.uk or P.Hibbard@surrey.ac.uk

Registration is £20 UK which includes refreshments and lunch.

Guildford is easily accessible from London (35 mins by train) and only 50 mins from Heathrow and Gatwick (rail-air links).

Abstracts

Temporal characteristics of stereoscopic slant perception

R.S. Allison(1), I.P. Howard(1), B.J. Rogers(2), and H. Bridge(2)

(1)Human Performance Laboratory, Institute for Space and Terrestrial Science, York University, Canada, (2) Experimental Psychology, Oxford University, UK.

Perception of stereoscopic slant and inclination depends on gradients of horizontal and vertical disparity (shear and size disparities). It has been proposed that the vertical mechanisms serve to protect stereopsis from spurious horizontal disparities arising from cyclo-disparity, aniseikonia and eccentric viewing. We hypothesized that vertical disparity is processed more slowly than horizontal disparity. Given this, we expect that the contribution of vertical disparity gradients will be diminished at high temporal frequencies or for brief presentations.
In 5 of 7 subjects, suprathreshold perceived slant and inclination measured by a matching task declined with increased temporal frequency for modulations of horizontal, vertical and deformation shear or size disparities. Two subjects who also showed slant reversal effects (Gillam, 1968) did not show this pattern clearly. For rotation or dilation disparities, perceived inclination or slant was small at low frequencies and increased for the mid-frequency range. With modulated dilation disparity, all subjects saw slant in the direction of the vertical component. This was opposite to the direction of slant seen with static dilation disparity. Note also that this is opposite to the direction we hypothesized. With static or modulated rotation disparity, all subjects saw inclination in the direction of the horizontal component. The time-course of the buildup of the slant or inclination percept was also studied by having subjects match the final slant or inclination seen in a test surface containing a disparity gradient as exposure time was varied.

Dissociating the what and where of stereopsis

Barton L. Anderson

Brain & Cognitive Sciences, MIT, E10 135, Cambridge, MA 02139.

For over a century, theories of stereopsis have assumed that binocular disparity provides a sufficient source of information for recovering three-dimensional surface structure. This assumption arises from the belief that the disparity field has a one-to-one correspondence to the perceived

relative depth of surface elements that are matched in the two eyes. From this perspective, if a unique match can be found for an image feature, then this feature should give rise to a single, local impression of depth. Here, I present new displays which reveal that this view of the mapping from disparity to perceived depth is incorrect. I show that the disparity field only provides information about relative depth, it does not uniquely determine what is assigned to a given disparity value. Specifically, I demonstrate that one- and two- dimensional textures containing a single value of disparity can appear as a combination of multiple surface layers when bordered by a more distant contour containing a uniform contrast polarity relationship relative to the texture. The near layer appears as a transparent surface that varies in opacity, while the far layer appears uniform in both lightness and opacity. Remarkably, the apparent lightness of the two layers can be completely transformed by simply varying the luminance of an adjacent background. These new phenomena demonstrate the existence of previously unknown interactions between neural pools tuned to the relative disparities of image contrasts that are used to compute the lightness and opacity of 3D surfaces.

Effects of surface orientation and number of surfaces on perceived slant in a 3D scene

George J. Andersen (1), Myron L. Braunstein (2) and Asad Saidpour (3).

(1) University of California, Riverside, (2) University of California, Irvine, (3) University of California, Riverside

Previous research (Andersen & Braunstein, 1997) has shown that judged depth and surface slant in some 3D scenes is greater for compression textures than for convergence or grid textures. For scenes containing a ground and ceiling plane, the relative effectiveness of compression depended on the simulated slant of the surfaces and the presence of a horizontal gap. The present study examined the relationship between type of texture, orientation of the surfaces in the scene, and the number of planes present in the scene in determining judged surface slant. Subjects were presented with computer generated scenes containing surfaces receding in depth, with each surface specified by either a compression, convergence or grid pattern. The orientation of the surfaces (horizontal or vertical) and the number of surfaces (one or two) were varied. In addition, the effects of surface slant (40 or 80 deg) and gap size (0, 1, or 2 cm) were examined. Subjects adjusted the slope of a line on a response monitor to match the apparent slant in depth of a surface

in each scene. The effectiveness of compression depended on the magnitude of the simulated surface slant, with greater slant reported for compression when the surface slant was closer to that of a ground plane (80 deg) than to that of a frontal plane (40 deg). The relative effectiveness of compression in determining judged slant was greater when the surfaces were oriented horizontally, suggesting an effect of an implied horizon, and when two planes were present in the scene.

Supported by NSF grants SBR9510431 and SBR9511198.

Uncoupling binocular disparity from relative luminance and relative size in stereoscopic displays

Peter Banton and Peter Thompson
Department of Psychology, University of York, Heslington, York, YO1 5DD

We have conducted a series of experiments that has uncoupled the usual relationship between disparity and other cues to depth. In this paper we discuss two such cues, luminance and size.

Under normal viewing conditions relative binocular disparity is coupled with other depth cues, for example relative luminance and relative size. Objects generally appear dimmer as they recede (aerial perspective) and a closer object subtends a larger visual angle than a similar farther object (relative size).

A series of experiments investigated subjects' ability to perform relative depth judgements with subjects making 'closer/further' discriminations between a 'test' disc and two 'standard' flanking discs. In Experiment 1 the luminance and disparity of the test disc relative to the flanking discs were varied independently. In Experiment 2 the size and disparity of the test disc relative to the flanking discs were varied independently. A baseline condition which contained no size or luminance manipulation showed all subjects were able to make accurate relative depth judgements on the basis of disparity alone. However, when disparity was confounded by relative size or relative luminance, some subjects were unable to produce accurate relative depth judgements. A subsequent experiment suggests that 30% of our subject population falls into this group.

We have found the performance of this group may be improved by increasing presentation time for the task but that practice with feed-back makes little difference.

The interaction of binocular disparity and motion parallax in determining perceived depth and perceived size: is the same estimate of 'd' used ?

Mark F. Bradshaw (1), Andrew D. Parton (1), and Richard A. Eagle (2)

(1) Department of Psychology, University of Surrey, Guildford, GU2 5XH.
(2) Experimental Psychology, University of Oxford, Oxford, OX1 3UD.

Although binocular disparity and motion parallax are powerful cues to an object's shape neither, in isolation, can specify information about both shape *and* size. However information from both cues can be combined to specify shape, size and distance (Richards, 1985 JOSA; Johnston et al, 1994 Vision Research). Possible interactions between disparity and parallax have typically been investigated using computer generated stimuli. However in the experiments reported here, natural viewing and physical stimuli were used as they have been shown to be important factors in the interpretation of experimental findings in depth perception (see Durgin et al, 1995 JEP:HPP). The stimuli consisted of 3 LEDs carefully aligned in the horizontal meridian and presented in darkness to form a 'T' shape. The base lights could be translated perpendicular to the midline (to set the size) and the apex light could be translated along the midline (to set the depth). The position of the LEDs were adjusted by the observer to match the size of one of two, differently sized, hand-held T-shapes (15 cm or 30 cm). Three observers made repeated settings with the base of the adjustable at 5 distances between 1.5 and 3 m. The experiment comprised monocular and binocular viewing and static and parallax conditions (head movements ±6.5 cm at 1 Hz). With static monocular viewing, performance (bias and accuracy) was very poor and erratic. For both depth cues, in isolation, performance improved markedly. Distance was clearly taken into account for both size and depth settings although different estimates of viewing distance seemed to be used (settings were precise). There was little obvious advantage when both cues were present simultaneously.

The relationship between depth perception and neural activity in primary visual cortex.

Bruce G. Cumming and Andrew J. Parker

University Laboratory of Physiology, University of Oxford, Parks Road Oxford.

There is considerable divergence in views about the role of V1 cortical neurons in stereopsis. The analysis of much experimental work on disparity selectivity uses simple local-filtering models based on the summation of inputs from different locations on the two retinae. Others have asserted that neurons in V1 play a central role in the solution of the binocular correspondence problem. We begin by highlighting the incompatibility of these two views and then proceed to some experimental tests that are designed to distinguish them unambiguously.
Recordings were made from single neurons in cortical area V1 of awake, behaving primates. Both animals and humans were tested psychophysically on the stereoscopic percepts elicited by the stimuli. We presented local binocular matches inside the neuronal receptive field that were inconsistent with the globally-perceived stereoscopic depth (as reported perceptually). In one case, the individual bars of sinusoidal stimuli presented within a sharply-defined circular window evoke responses from disparity-selective cortical neurons. A configuration was used in which the perceived disparity of the entire pattern was constrained by the window to be different from the local disparity of the bars within the receptive field. In another case, anti-correlated random-dot stereograms were used to place binocularly consistent stimulation within the receptive field of V1 cortical neurons. No depth is perceived with these anti-correlated random-dot patterns. In both cases, the responses of V1 neurons was in accord with the local filtering model and not with the view that these neurons are able to solve the binocular correspondence problem.
These experiments suggest that the responses of V1 neurons in the awake, behaving primate are consistent with some of the simplest versions of the local filtering models. Therefore, considerable processing beyond area V1 is required to extract the signals that actually dominate the perceptual experience of stereoscopic vision.

Systematic Perceptual Distortion of the Normal to a Plane may be Explained by Errors in Perceived Viewing Distance

Philip A. Duke (1), John P. Frisby (1), John Porrill (1), David Buckley(2)

(1) Department of Psychology, University of Sheffield, Shefield S10 2TN, UK (2) Department of Ophthalmology & Orthoptics, University of Sheffield, Sheffield S10 2TN, UK

Depending on the task and stimulus, poor performance can be found where observers are required to make judgements of metric properties. One interpretation of such results is that visually perceived space has an intrinsically non-Euclidean representational framework. Another interpretation is that the framework may be Euclidean, though under particular conditions the visual system generates percepts based on incorrect estimates for certain viewing parameters. We report an experiment examining performance on a task where observers were asked to adjust a probe to appear normal to a plane. This surface appeared at a range of viewing distances and angles of slant around the horizontal axis, and was real as opposed to computer generated. Stereo was the dominant cue to depth. A pattern of errors was found which may be seen as poor performance on this task. We show that modelling the error data in terms of disparity scaling based on a misestimation of distance can explain the results. This supports the interpretation that internal space may be Euclidean in nature. The data suggest that observers are building metric representations, but errors arise due to incorrect calibration. We also suggest that certain results described as depth contrast effects and certain instances of the operation of the equidistance tendency (Gogel, 1965) can be explained in terms of errors in specific quantities required by the visual system for proper calibration.

The recovery of structure from motion under perspective and orthographic projection.

Richard A. Eagle and Maarten Hogervorst

Experimental Psychology, University of Oxford.

If a rotating object is viewed under two-frame orthographic projection, it is theoretically impossible to disambiguate its 3-D structure and motion. Increasing the number of frames or using perspective projection renders this problem soluble, subject to the visual system's sensitivity to the image motion.
We recorded observers judgements of the dihedral angle of a hinged plane

(an “open book”) that rotated about a vertical axis. We varied both the display size (8° “S” vs. 32° “L”) and the projection type (orthographic “O” vs. perspective “P”). The monocularly-viewed structures spanned a range of dihedral angles (35 - 169°) and rotation angles (2 - 58°). Subjects judged the dihedral angle by matching it to that of a large-field probe stimulus defined by binocular disparity, texture and a large rotational motion, viewed under perspective projection.
Spearman Rank Order correlations of subjects' settings with the simulated dihedral angles were high in condition LP ($r_s = 0.93$) and decreased from LP -> SP -> SO -> LO. In the same order, correlations with the total displacement of the projected points increased, up to $r_s = -0.94$ in condition LO, indicating that structure and motion became increasingly confounded. These results show that the visual system makes effective use of the additional information provided by perspective projection. In contrast, the use of orthographic projection forces the visual system into an over-reliance on the total displacement of projected points, especially for large stimuli.

Supported by The Wellcome Trust and The BBSRC 43/SO5036.

Visual processing deficits and dyslexia

John Everatt, Mark F Bradshaw, Paul B Hibbard & Martin Lages

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Dyslexia is often viewed as a difficulty in the acquisition of literacy skills; the most often quoted symptom being problems with reading. Although the linguistic (phonological) deficit viewpoint has dominated the literature, a number of theories propose a visual deficit as the basis of the disability: Lovegrove (1991, Cog. Neuro. 8 435-441) presents data that dyslexics have a transient processing deficit which should be evident in tasks which require, for example, motion perception; Stein and Walsh (1997, TINS 20, 147-152) argues that such a transient (or magnocellular) deficit is related to poor (particularly binocular) eye movement control; Irlen (1991) suggests that many dyslexics have, what she terms, scotopic sensitivity syndrome, which may be alleviated by tinted lenses (eg, Wilkins et al, 1994, Ophthal. Physiol. Opt 14 365-370) and related to deficits in depth perception. The present study used a number of measures to assess these different views and investigate commonalities between them. Of the diagnosed dyslexic adults assessed, approximately 30% presented consistent evidence of difficulties on measures of motion and disparity.

These included D_{min}, D_{max}, coherence thresholds, binocular disparity thresholds and the ability to discriminate shapes in large disparity stereograms where precise eye movement control is required. The remainder performed equivalent to controls across all measures. Implications of these findings will be discussed.

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Cues to viewing distance for stereoscopic depth constancy

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A veridical estimate of viewing distance is required in order to judge the peak-to-base disparity corresponding to a circular cylinder (Johnston, 1991). Most studies report underconstancy in this task when the stimulus is defined purely by binocular disparities.
We examined the effect of four separate factors on performance: (i) the richness of the cues to viewing distance (using either a naturalistic setting with many cues to viewing distance or a condition in which the room and the monitors were obscured from view); (ii) the experience of the observers (who were either naive to the purposes of the experiment and initially unaware of the room layout or others who had performed the task many times before under full-cue conditions); (iii) the range of stimulus disparities (cylinder depths) presented and (iv) the psychometric procedure (adjustment or forced choice). All had some effect on constancy.
Depth constancy was reduced for the naive observers (from about 60% to 45%) when the position of the monitors was obscured and settings were made with an adjustment procedure. Under similar conditions, the experienced observers showed no reduction in constancy.
The range of stimulus disparities had little effect on constancy when an adjustment technique was used. However, when a forced-choice, method-of-constant-stimuli paradigm was used, with the positions of the monitors obscured from view, the range of stimulus disparities had a significant effect. Constancy was reduced from 64% to 23% in naive observers and from 76% to 54% in experienced observers when the same set of stimuli was presented at all viewing distances rather than using a range of disparities proportional to the correct setting.
One possible explanation of these results is that, under reduced-cue

conditions, the range of disparities presented is used by the visual system as a cue to viewing distance.

The critical factors determining the strength of the stereoscopic slant response

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Stereoscopic slant (as opposed to inclination) can be markedly attenuated when viewing a single surface (Gillam 1968, Gillam et al., 1984, 1988, Erkelens and van Ee, 1994, Kaneko and Howard, 1995). When a second frontal plane surface is present however the slant may emerge quickly and according to prediction. There have been several explanations of this striking effect.(a) that first derivatives of disparity are ambiguous and / or stereopsis is especially sensitive to second derivatives of disparity (b) that slant contrast or a frame of reference enhances the stereoscopic slant response and (c) that stereoscopic depth is always a response to relative disparity and that fast stereoscopic slant requires a gradient of relative disparity which is not present for a single slanted surface. The logic underlying and evidence for each of these processes will be considered. The latter includes (a) the effect of varying the relative placement of the two surfaces, which determines whether or not a gradient of relative disparity is present, (b) the effect of the separation of the surfaces both in the plane and in depth, which would be expected to influence the responses to the relative disparities present across the intersection and (c) the way the relative slant is assigned to the perceived absolute slants of the two surfaces (including considerations of normalisation and contrast) and the factors which determine this.

Does temporal delay affect pointing accuracy in open-loop pointing in adults and children?

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This paper reports an experiment on the effect of temporal delay on open-loop pointing in adults and children. Previous research on adults has shown that a delay of 2 seconds significantly affects the accuracy of pointing in open-loop conditions when making fast (400-500msec) but not slow (200-300msec) movements (Digby and Madalena 1987). Developmental work (eg Bard, Hay and Fleury 1990) has not explored temporal effects but has demonstrated that children are less accurate than adults and are particularly prone to error around the age of 7-8 in open-loop pointing tasks. The current experiment explores the effect of delay on both adults and children ability to point to a target located in three dimensional space. Fifteen adults and 13 children (aged 5-10) were required to point to laser projected targets (both midline and lateral) following a temporal delay of 0,1,2 and 4 secs following target extinction. The movements were unrestricted both temporally and spatially and were carried out in total darkness. Responses were recorded for both accuracy and time taken from movement initiation to estimated target position. Overall adults were more accurate than children for mean amplitude error but there were no significant differences between the different ages of children. In terms of delay, children were markedly affected by increasing delay with increased errors on both direction and amplitude. Adults were affected by delay in terms of amplitude error only. These data are consistent with the findings from Digby and Madalena (1987) on adult performance and demonstrate that children are particularly sensitive to temporal delay. However these findings do not replicate the non-monotonic developmental trend found in previous research in which children's pointing movements were spatially constrained.

Perceived depth and retinal disparities.

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Under suitable circumstances, stereoscopic fusion of disparate images creates a convincing impression of three-dimensional depth. The exact relationship between a given disparity and the amount of depth perceived is less clear. In particular it has yet to be demonstrated that the depth sensation that is induced by retinal disparity is appropriate ("veridical") for the disparity map, or that it corresponds to the true depth of a real object. Geometrical considerations predict a simple linear relationship between perceived depth and the amount of disparity, and this is the relationship that is widely believed to hold.

Evidence will be presented from psychophysical experiments on depth

matching that indicates that the apparent depth in a stereogram not only depends on the disparity, but is also influenced strongly by the precise geometrical arrangement of the depth map. In particular, for both step edges and sinusoidal corrugations in depth there is a marked orientation anisotropy. Further, there are marked differences in the perceived depth / disparity function between targets whose depth profile crosses the fixation plane, and those that are uni-polar (comprised solely of crossed or uncrossed disparities).
A theoretical model of depth perception will be presented that explains qualitatively both the meridional variation and the effect of disparity type. The model has many similarities with models in the luminance domain. The disparity map is convolved with a spatially band-pass depth filter with an elliptical "receptive field". This filter is constructed by lateral inhibitory connections between lower level mechanisms that are tuned to crossed and un-crossed disparities. Integration of the output of the convolution process yields the metric that represents image depth. The elliptical shape of the filter results in the meridional anisotropy in perceived depth for targets that have a disparity profile that crosses the horopter. However, for targets that are uni-polar in disparity, the band-pass characteristic of the filter is lost, and it becomes, in effect, low-pass with an accompanying change in the shape of the perceived depth / disparity function.

Is global motion processing tuned for binocular disparity?

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An important goal of visual processing is the segmentation of retinal images into figure and ground. This may be achieved if the figure is defined, for example, by an orientation, a colour, a motion or by a disparity which is distinct from its background. Recently, it has been shown that our ability to detect a figure defined by directional motion in the presence of noise is greatly facilitated if the signal dots are made distinct on the basis of colour (Croner and Albright, 1994, ARVO). Here, we address whether binocular disparity could produce a similar facilitation, a hypothesis which is supported by the fact that many cells in the visual pathway (MT and MST) which are tuned to disparity are also tuned to the direction of motion. Coherence thresholds were measured for the discrimination of the global direction of motion of RDKs, in which the distributions in depth of signal and noise dots were independently manipulated. When signal and noise dots were intermingled in depth, binocular disparity did not facilitate the discrimination of the direction of motion. However, when the signal dots were clearly segregated from the noise dots in depth, facilitation was found i.e. the coherence required to discriminate the global direction of motion was greatly reduced. In a final experiment, we investigated whether binocular disparity could facilitate the detection of transparent motion, which is suggested strongly by the recent physiological findings of Bradley et al (1995, Nature). However, again no facilitation of performance was found. In conclusion, little evidence was found to suggest that global motion processing is tuned for disparity, except when the disparity clearly demarcates the signal dots from the noise dots. In this case, however, the improvement in performance found is probably due to an attentional strategy adopted by the observer.

Biases in perceived structure from motion explained by a Bayesian model.

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We performed an experiment in which subjects judged the dihedral angle of a hinged plane (an “open book”) defined by motion by matching it to a probe defined by binocular disparity, motion and texture. Perceived dihedral angle was found to be influenced by the amount of rotation for small angles of rotation and/or small dihedral angles, but less so for large rotation angles and large dihedral angles. In order to account for these biases, we developed a Bayesian model that incorporates (i) measurements of the image motion; (ii) estimates of the measurement errors and (iii) assumptions about the underlying 3-D scene. Noise levels were estimated from discrimination thresholds for velocity (De Bruyn & Orban, 1988) and detection thresholds for changes in velocity (Snowden & Braddick, 1991; Werkhoven et al., 1992). The model assumes that every dihedral angle as well as every rotation angle (within a certain range) is equally likely to be encountered. This model predicts the biases in the experimental data, and suggests that they result from optimal combination of the available image data with assumptions about which scenes are likely to be encountered.

De Bruyn, B., Orban, G.A. (1988), *Vision Research* **28**, 1323-1335

Snowden, R.J., Braddick, O.J. (1991), *Vision Research* **31**, 907-914.
Werkhoven, P., Snippe, H.P., Toet, A. (1992), *Vision Research* **32**, 2313-2329

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The effects of eccentricity, vergence angle and elevation upon the relative tilt of corresponding vertical and horizontal meridia revealed using the minimum motion paradigm.

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When the horizontal meridia of the two eyes are aligned, the corresponding vertical meridia are tilted outwards in a temporal direction by approximately 2 degrees, a phenomenon first described by Helmholtz. However, it is not known if this effect is confined to the fovea or whether the same relationships exist between corresponding horizontal and vertical meridia at eccentric retinal locations. We sought to address this issue by exploiting the technique of Nakayama (1977) in which the positions of alternating dichoptic images that produce minimal apparent motion were used to measure the relative tilt of corresponding meridia at a range of eccentricities up to 16 degrees away from the fovea. Stimuli were composed of dichoptic images of either a pair of dots or extended lines which alternated at a rate of 0.63 Hz and had a relative tilt (binocular orientation difference) of between ±5 degrees. Nonius lines were used to maintain vergence angle, which was varied between 28 cm and infinity. Subjects judged which pair of alternating images produced the smallest amount of apparent motion (position change). It was found that at all eccentricities measured the corresponding horizontal meridia were generally aligned but the corresponding vertical meridia were consistently offset by about 2 degrees. Corresponding horizontal meridia were altered when the vergence angle was varied but corresponding vertical meridia were largely unaffected. With the eyes held in an elevated position, both horizontal and vertical meridia were altered by a comparable amount when vergence angle was altered, indicating a change in cyclovergence.

Nakayama, K. (1977). Proc. of Soc. of Photo-Optical Engineers, 120, 2 - 9.

Perception and measurement of surface orientation

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Perception of surface orientation is often found to have a small variability but large biases. The common interpretation of this result is that observers built a non-veridical representation of the depicted surface. We investigate here the alternative interpretation that the probe commonly used to report the perceived surface orientation is itself prone to errors.
For this purpose, we designed an experiment in two stages. In the first stage, a prototypical object was placed in front of an observer. Objects were vertically oriented cylinders portrayed by random dot stereograms. The cross-section of the cylinder was a cubic spline whose parameters were adjusted until it appeared circular. In the second stage of the experiment, an orientation probe was superimposed on this apparently circular cylinder. The probe consisted of two concentric discs with an orthogonal post. Observers had to orient this probe at several locations until the discs appeared tangent to the surface.
All observers displayed significant biases in their reports of the surface orientation. Because the surface was beforehand matched to each observer's internal representation of a circular cylinder, these biases reflect errors intrinsic to the use of the probe. Therefore, it appears that the deformations previously found in the perceived surface shape are partially due to a misuse of the experimental probe.

A curious illusion suggests complex interactions in depth perception

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Binocular perception of the distance to, and between, point light targets depends on vergence angle: increasing vergence angle decreases apparent distance and vice versa. We tested whether this effect occurs in more structured visual environments by manipulating vergence angle using an ophthalmic prism. Placing a prism 'base-out' requires increased convergence for target fixation; 'base-in' requires decreased convergence: the triangulation account of depth perception predicts that apparent target

distance should decrease and increase respectively. The expected result was not observed. Instead a consistent illusion of perceived distance was obtained: egocentric target distance was judged to be significantly greater regardless of prism orientation or target distance. We provide an explanation for this phenomenon: the explanation is founded on the natural responses of a perceptual system which reaches a self-consistent representation of external 3-Dimensional space on the basis of mutually interacting cues to distance. A model based on this idea allowed us to predict modulations of the over-estimate with simple manipulations of the viewing environment. Further experiments confirmed these predictions.

When texture is a stronger depth cue than motion

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Both texture and motion can be strong cues to depth, and estimating surface slant from texture cues is analogous to calculating slant from motion parallax (Malik & Rosenholtz, 1993). A study was performed to determine the relative weight of texture and motion cues in the perception of planar surface slant when both motion and texture convey similar information. Stimuli were monocularly-viewed images of planar surfaces slanted in depth, in which texture and motion information could be varied independently. Slant discrimination biases and thresholds were measured using a method of single stimuli, binary choice procedure. Perceived slant was measured as a function of the difference between motion and texture slants. Two textures were used: a regular plaid and an irregular cloud-like texture. Three types of motion were used: 1D shearing; 1D compression; and the 2D sum of the two. When motion slant was constant and texture slant varied by up to +/- 12 degrees, perceived slant varied by >80% of the change in texture slant. When texture slant was constant and motion slant varied, perceived slant varied by <10% of the change in motion slant. With the irregular texture there was limited evidence of a decrease in the weight of the texture cue. In a further study, it was demonstrated that thresholds for perceiving changes in 1D and 2D velocity gradients are about 30% higher than thresholds for changes in 1D and 2D spatial frequency gradients.

A comparison of binocular and monocular detection of sinewave gratings in two-dimensional noise

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We have measured the contrast thresholds for detecting Gabor patches of 6 c/deg in two-dimensional random pixel noise. By varying the spectral density of the noise we have analysed the independent contributions of equivalent noise and sampling inefficiency to contrast threshold. The equivalent noise gives a measure of the internal noise while the sampling efficiency indicates how efficiently the visual system utilises the available stimulus information. Data from ten subjects who were allowed indefinite exposure duration showed that in comparing binocular viewing conditions to monocular, there is both an increase in the sampling efficiency and a decrease in the equivalent internal noise level in the visual system.Implications for existing theories/models for binocular summation are discussed.

Coarse to fine, cyclopean processing

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Previously (Popple et al., in press) we found, using random-dot stereograms, that initial vergence increases with the size of a cyclopean disc. A corresponding improvement in stereoacuity within the disc was predicted, because disparities in the disc would be brought closer to the plane of current fixation.
In the present experiment, we looked at the effect of the spatial extent of a briefly presented (500 msec) cyclopean depth pedestal on stereoacuity thresholds. Observers were required to judge the depth of a small 1.7° central disc relative to a larger surrounding disc in a random-pattern stereogram. The larger disc was set, initially, at a pedestal disparity of ±24, against a fixation-plane surround. The size of the larger disc was varied from 2.6°-8.0°. As predicted, stereoacuity thresholds declined significantly with increasing pedestal disc size. Next, the disparity of the pedestal disc was varied. When pedestal disparity was reduced to ±2.4,, a disparity too small to demand vergence, the size effect disappeared. This

shows the effect was due to vergence and not cyclopean integration alone. As a result of improved initial vergence, we are able to detect finer depth variation on an extended coarse-disparity pedestal. Coarse disparities are integrated over a relatively large area to stimulate vergence, which then brings into register the finer disparities within this region, used to determine stereoacuity.

Popple, A.V., Smallman, H.S. and Findlay, J.M., (in press), The area of spatial integration for inital horizontal disparity vergence, Vision Resarch.

Stereo masking reveals spatial-frequency channels.

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Yang and Blake (1991) asked subjects to detect depth in stereograms containing spatially narrowband signal and noise energies. The resulting masking functions led them to conclude that stereo vision was subserved by only two channels peaking at 3 and 5 cycles/degree. Glennerster and Parker (in press) re-analysed these data, taking into account the relative attenuation of low and high frequency noise masks due to the initial modulation transfer function (MTF) of the visual system. They transformed the data using an estimated MTF and showed that peak masking was at the signal frequency across a 2.8 octave range. Here we determine the MTF for individual subjects by measuring contrast thresholds in a 2AFC discrimination task (horizontal vs. vertical) using band-limited stimuli presented in a 7 x 7° window at 4° eccentricity. The filtered stimuli were 1.5 octaves in frequency and 15° in orientation at half-height. In the subsequent stereo experiment, the same (vertical) filters were used to generate both signal and noise bands. The noise was binocularly uncorrelated and scaled by each subject's MTF. Subjects performed a 2AFC depth discrimination task (crossed vs. uncrossed disparity) to determine threshold signal contrast as a function of signal and mask frequency. The resulting functions show that peak masking is at the signal frequency over the three octaves tested (0.4-3.2 cycles/degree). Comparison with simple luminance masking data using similar stimuli shows that bandwidths for stereo masking are considerably larger. These data suggest that there are multiple bandpass channels feeding into stereopsis but that their characteristics are different from luminance

channels in pattern vision.

Glennerster, A. & Parker, A.J. (in press) Vision Research.
Yang, Y and Blake, R. (1991) Vision Research, 21, pp. 1177-1189.

Is eye of origin labelled?

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Because subjects cannot perform utrocular discrimination tasks, Graham (Visual Pattern Analyzers, Oxford University Press, 1989) concludes that the optic nerve fibres are not labelled for eye of origin. On the other hand, Shimojo and Nakayama (Vision Research 30, 69-80, 1990) claim that the fibres must be labelled, else one could not tell the difference between crossed and uncrossed disparities.
This confusion arises because the word 'label' is being used in two different senses. Graham is working in a tradition, that goes back to the nineteenth century, in which labels are seen as indicators-of-origin that carry information about the stimulus that is used for perception. Such labels must necessarily pass from one stage of serial processing to the next without losing their meaning. The alternative view is that any given label exists only fromone stage of processing to the next. At each stage, new labels have to be synthesized, because the representation of the stimulus has been transformed or re-encoded in some way, so the meaning of each cell's activity has changed. Thus at the stage where depth is extracted for stereopsis, afferent eye of origin labels are converted to crossed/near and uncrossed/far labels for transmission to further stages of processing.
The theory of labelled lines has many such inconsistencies and weaknesses that will ne reviewed and clarified.

The minimum contrast requirements for stereopsis.

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Despite several studies in the last ten years, there is still no consensus on what are the minimum contrast requirements for stereopsis. Consequently, a number of experiments were performed in which contrast thresholds for the identification of stereoscopic depth (front/back) were measured.

Using stimuli that were localized in both space and spatial frequency (Gabor patches and DoGs), it was ascertained that a range of disparities can always be bound over which contrast thresholds for depth identification are less than or equal to those for simultaneous monocular detection (SMD) of the stereoscopic half-images (see Simmons and Kingdom (1994) Vis. Res. 34, 2971-2982). The correlation between this disparity range and the stimulus spatial frequency content is consistent with the link between spatial frequency and disparity tuning that has been suggested in a number of studies (e.g. Smallman and MacLeod (1994), JOSA A 11, 2169-2183). Furthermore, the fact that these judgements are possible at such low contrasts is consistent with the notion of "labelled lines" for stereopsis. The manipulation of interocular contrast ratio results in higher contrast thresholds for stereopsis than expected from SMD. There is some evidence that this effect is partly caused by inhibitory interactions between higher contrast stimuli (i.e. when the higher of the two monocular contrasts is about 2x SMD threshold). SMD also successfully predicts stereoscopic performance for some stimuli with broader spatial bandwidths, such as Gaussian blobs. The implications of the scope of application of the SMD prediction for models of stereopsis and binocular visual processing will be discussed.

Evidence for cyclopean motion energy mechanisms

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Are there specific mechanisms sensitive to stereo-defined motion? We used a drifting, horizontal, 0.25 c/deg, missing-fundamental stimulus, defined purely in stereoscopic depth, to address this question. The phase of the missing-fundamental was incremented in 90 deg steps at a rate of 16.7 Hz. The dynamic random binary noise used as a carrier was updated at the same frequency. The missing-fundamental waveform moved either upwards or downwards, and observers indicated perceived direction in a single-interval, binary-choice task with no feedback. The amplitude of the missing-fundamental waveform varied between 3.5 and 21.2 minarc disparity. When performance was not at chance levels, motion was seen in the opposite direction to the phase shift of the sequence, implying that observers were following the (aliasing) largest Fourier component in the stimulus, and not the spatial features of the image. In a second experiment, the 3f and 5f components of the missing-fundamental were presented separately, to control for the possibility that any perceived reversal of the missing-fundamental sequence could be attributed to attenuation of higher spatial frequency components in the image. Both components were found to be equally visible. The backwards motion of the missing fundamental stimulus implies that low-level mechanisms, sensitive to stereoscopic motion energy, mediate cyclopean motion perception.

In a third experiment, observers indicated the orientation and direction of a drifting 0.5 c/deg sinusoid, defined only in depth, in a single-interval, two-binary-choice task with no feedback. Orientation thresholds (in terms of disparity) were lower than direction discrimination thresholds, as is the case for 2nd-order motion (Smith and Ledgeway, 1997, Vision Research, 37, 45-62) and colour-defined motion (Lindsey and Teller, 1990, Vision Research, 30, 1751-1761), but not for luminance gratings (Watson et al, 1980, Vision Research, 20, 341-347).

We conclude that motion-specific mechanisms sensitive to cyclopean stimuli exist, and that their properties more closely resemble those of 2nd-order than 1st-order mechanisms.

Stereo depth perception from linear combination of first and second-order disparities

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We studied how binocular disparity cues are combined in the perception of depth magnitude. Depth estimates relative to a reference plane were obtained for grating patches (Gabor functions, 2 c/deg carrier, 32% contrast) across a wide range of conditions in which first and second order disparities (i.e. disparities of the carrier and the envelope of the patches) were independently manipulated. When the two disparities were of opposite sign perceived depth followed the carrier at smaller disparities, but reversed to follow the envelope at larger disparities. No depth was seen from envelope disparity when the carrier had zero disparity.

We propose a descriptive model for these data in which first and second order disparity values are linearly combined, and then translated into a depth response. At the summation stage the two disparity signals are weighted such that the influence of the first order signal decreases, and the second order influence increases, as disparity magnitude increases. For vertical carriers the weights sum to 1, but for tilted carriers the first

order influence decreases as the cosine of the tilt.
Phase disparities for gratings are inherently ambiguous, as in the wallpaper effect. However, we observed that when envelope disparity was zero, a 180 deg carrier disparity was unambiguously perceived as behind the reference plane, rarely in front. This suggests that occlusion cues consistently guide the use of ambiguous disparities, and we propose further that binocular occlusion relations can be sensed from a comparison of the two types of disparity. When the model includes this constraint it can account well for the complex interactions between cues in stereopsis.

A curvature contrast effect for stereoscopically-defined surfaces

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Purpose: Global aspects of a scene often influence our perception of local object properties, because our visual system frequently uses relative rather than absolute measures. Such spatial contrast effects have been found for many different aspects of vision and it has recently been reported that a curvature contrast effect exists for stimuli defined by texture and shading cues (Curran & Johnston, Vis. Res. 1996). In the present study we sought to investigate the effect of global curvature on the perception of local curvature using stereoscopically-defined stimuli.
Methods: Stimuli were composed of random-dot-stereograms subtending 20 degrees and consisted of two horizontally oriented parabolic cylinders presented to vertically-adjacent regions of the observer's field of view. Both cylinders were composed of two identically curved inducing flank cylinders, one on either side of a centrally located strip (width 5 degrees) with a different curvature. The curvature of one of the central strips (reference) was fixed whilst that of the other strip (test) was under control of the subject. Subjects were asked to adjust the curvature of the test strip until it appeared to be the same as that of the reference strip.
Results: We find a considerable curvature contrast effect for disparity-defined surfaces. Furthermore, the same basic pattern of results was found when the reference strip was offset in depth or slanted with respect to the test strip, suggesting that observers were not basing judgements on direct comparisons of either local depth or slant.
Conclusions: The curvature contrast effect we find for stereoscopically-defined surfaces is comparable to that found for surfaces defined by texture and shading cues.

Using multiple sources of information about relative distances between three collinear dots rotating in a slanted plane.

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Displays were presented consisting of orthographic and perspective projections of three collinear dots rotating rigidly around a fixed center in a plane slanted 45° in depth. Observers were asked to decide whether the middle of the three dots was exactly centered in 3-D space between the other two dots. The visible rotation segments were 120, 160, or 200° and the displacements were 2%, 4%, or 6%. Our untrained observers performed more poorly overall than well-practised observers tested earlier by Lappin and Fuqua (1983 Science 221 480-482). Results of additional manipulations suggested that 2-D image properties played a more important role than acknowledged by Lappin and Fuqua. First, displacement size and the position of the rotation center produced nonlinear effects. Second, the direction of displacement affected performance. Third, projection type and display type (static snapshots versus elliptic traces) were involved in complex interactions. Clearly, performance was affected by 2-D image properties that should be irrelevant to the calculation of 3-D projective invariants. Regression of performance levels on relative changes in several different cue values revealed a tendency to use those sources of information which are most reliable and easiest to extract given the specific stimulus conditions. In general, the well-established hierarchy between geometries was confirmed perceptually by the visual system's preference for Euclidean distance cues, affine length ratios, and projective cross ratios, respectively.

The effects of stereoscopic depth upon illusory pausing in random dot patterns

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Illusory pausing occurs when two identical random dot displays drift past one another. With full wraparound, the dot displays spatially coincide twice in a cycle, and at these points the motion in the display appears momentarily to cease, even though the velocities of the two arrays are in fact constant. It was previously shown that pausing in a horizontal (left

versus right) counter-drifting display does not depend on absolute spatial coincidence of the dots, but persists, with decreasing strength, as an increasing vertical spatial offset is introduced. This provides a means for measuring the strength and 2D domain of the illusion.
The question we investigated was whether the illusion depends on the dots being perceived as a single surface, or whether it is compatible with stereoscopic transparency. A method of adjustment was used in which the subject adjusted the vertical offset of the dot arrays until the illusion just disappeared. Trials were conducted at a number of disparity magnitudes, with magnitudes of equal disparity and opposite sign (near/far) being presented in any one trial. It was found that the vertical offset threshold was constant (10 arcmin) up to about 5 arcmin disparity, then decreased with increasing disparity, slope approximately -1. It was the disparity separation between the planes rather than nonzero disparity that affected the strength of illusion, since moving the fixation disparity away from the disparity of the two planes did not affect illusion strength. Randomising dot positions in the horizontal plane to eliminate exact coincidence shifted the above curve downwards, but the range of constant illusion strength (approx 5 arcmin disparity) remained the same. It was found that the range of constant illusion strength corresponded with the range in which a single (thickened) surface was seen (pyknostereopsis), and the range over which illusion strength decreased coincided with the emergence of two distinct transparent planes (diastereopsis). If the explanation of illusory pausing is that opponent motion signals cancel within a 2D spatial domain, we show here that this domain is measurable in 3D and the illusion is reduced by stereoscopic transparency.

Why do cars hit children?: dismissing the role of relative size in driver judgements of depth.

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Stewart, Cudworth & Lishman (1993) proposed that a primary determination of child-pedestrian accidents was a depth-from-size error by car drivers. They argued that the smaller optical size of children led drivers to assume that they were at a greater depth, thereby creating a “deadly illusion” (New Scientist,1994). The empirical support provided by Stewart et al was confounded by two methodological issues: i) Their driving simulation only provided participants with a discrete pre-programmed brake response that didn't allow for late adjustments. ii) The displays used were impoverished and many of the natural cues to depth were removed. We replicated the study of Stewart et al (1993) using a large-screen driving simulation with participants sat in a fully equipped vehicle. We compared responses to adult/child sized "virtual" pedestrians when the driver had a pre-programmed brake response (i) or a brake-pedal with continuous action. We also compared displays that were fully textured and that contained objects of familiar size (e.g. other vehicles) with a display that was reduced to a figure on a uniform background (as used by Stewart et al, 1993). We found that drivers only hit virtual-children when (i) the brake response was pre-programmed, (ii) cues other than optic size were removed. If either (i) or (ii) were changed then drivers were able to stop short and in a more naturalistic display with a continuously active brake pedal there was no difference in the stopping distance for (virtual) children or adults. We conclude that the "deadly illusion" of Stewart et al (1993) was probably an artifact of their experimental situation and should not be posited as a factor in the inceasing number of child-pedestrian accidents.

Grasping the impossible: estimating time to contact from monocular and binocular parameters.

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Estimating the immediacy of an impending collision is a task that is essential for many animals and such judgements are executed with considerable precision by elite sports-persons. The dominant account of time-to-contact (TTC) judgement has been through optic-looming (e.g. Tau: Lee, 1976), although it has been argued that the support for this account is ethereal (Wann, 1996). Binocular information also has some influence on TTC judgement and this can be demonstrated by scaling the binocular viewpoints during an interception task (Judge & Bradford, 1998; Heuer, 1993). Although models have been proposed for combining binocular and looming inputs for simple motion-in-depth (e.g. Regan & Beverley, 1979; Cumming & Parker, 1994) equivalent models for TTC judgement have not been tested. We consider two candidate models that combine binocular and monocular inputs either, after TTC estimation on respective streams, or prior to TTC estimation on either input stream. Both models can produce identical outputs for natural interception tasks, but produce different predictions when the input streams are perturbed. We tested the models by presenting participants with the task of catching virtual-balls, using a head-mounted display and instrumented glove. Virtual balls that presented coherent looming and binocular motion were compared with those where looming was computationally scaled so that there was a precise temporal offset between TTC indicated by looming or binocular motion. The results support a model of where looming and binocular inputs are combined in a common motion-in-depth stage before TTC is estimated.

Range effects in the psychophysical determination of contrast thresholds for stereopsis.

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A range effect is present if psychophysical performance for a given physical stimulus varies with the range of stimuli presented during the course of the experiment. Few attempts have been made to explain such effects. To this end, contrast thresholds for stereoscopic depth identification (front/back) were measured using Gabor stimuli. The number and range of contrasts presented, and the total length of the experiment, were manipulated. The largest range effects were found when the experiments were relatively long (240 trials) and the range of contrasts large (five equally spaced contrasts). For example, one subject obtained 90% correct performance at a contrast of 0.03 when this stimulus contrast was one of the highest presented, but only 68% correct when it was the lowest contrast presented. This performance difference contributed to a contrast threshold difference of 5.6 dB (almost a factor of 2) between the two cases. Optimal performance for both subjects was found when single contrasts were presented in short experiments (48 trials each). Previous explanations of similar effects have referred to the “central tendency of response” (Poulton (1974) “Tracking skill and manual control”, Academic Press) in which subjects’ performance adjusts so that it is good at one end of the range and bad at the other, irrespective of where the range sits on the continuum of interest. This could be caused by some form of low-level adaptation to the range of stimuli presented. An alternative explanation concerns higher-level factors such as the attentiveness in motivation of the subject. Ways of distinguishing whether either or both high- and low-level factors are causing these range effects will be discussed.

Selected References

Kaas, JH (1996) Theories of visual cortex organization in primates: areas of the third level. Progress in Brain Research, 112, 213-221.

King, AJ, Schnupp, JWH, Carlile, S, Smith, AL and Thompson, ID (1996) The development of topographically-aligned maps of visual and auditory space in the superior colliculus. Progress in Brain Research, 112, 335-350.

Kiorpes, L and Movshon, JA (1996) Amblyopia: a developmental disorder of the central visual pathways. Cold Spring Harbor Symposia on Quantitative Biology, 61, 39-48.

Koch, C and Braun, J (1996) The functional anatomy of visual awareness. Cold Spring Harbor Symposia on Quantitative Biology, 61, 49-57.

Sprague, JM (1996) Neural mechanisms of visual orienting responses. Progress in Brain Research, 112, 1-15.

Wessinger, CM, Fendrich, R, Gazzaniga, MS, Ptito, A and Villemure, JG (1996) Extrageniculostriate vision in humans: investigations with hemispherectomy patients. Progress in Brain Research, 112, 405-413.

Alfvin, RL and Fairchild, MD (1997) Observer variability in metameric color matches using color reproduction media. Color Research and Application, 22, 174-188.

Andersen, RA (1997) Neural mechanisms of visual motion perception in primates. Neuron, 18, 865-872.

Applegate, RA and Howland, HC (1997) Refractive surgery, optical aberrations, and visual performance. Journal of Refractive Surgery, 13, 295-299.

Bach, M (1997) A note on luminance calibration of raster-scan cathode-ray tubes: temporal resolution, ripple, and accuracy. Spatial Vision, 10, 485-489.

Banks, MS, Vanee, R and Backus, BT (1997) The computation of binocular visual direction: a re-examination of Mansfield and Legge (1996). Vision Research, 37, 1605-1610.

Baumann, R, Vanderzwan, R and Peterhans, E (1997) Figure-ground segregation at contours: a neural mechanism in the visual cortex of the alert monkey. European Journal of Neuroscience, 9, 1290-1303.

Bhattacharyya, P and Ganesan, L (1997) An orthogonal polynomials based framework for edge detection in 2-D monochrome images. Pattern Recognition Letters, 18, 319-333.

Birt, CM, Shin, DH, Samudrala, V, Hughes, BA, Kim, C and Lee, D (1997) Analysis of reliability indices from humphrey visual field tests in an urban glaucoma population. Ophthalmology, 104, 1126-1130.

Blohm, W (1997) Lightness determination at curved surfaces with applications to dynamic range compression and model-based coding of facial images. IEEE Transactions on Image Processing, 6, 1129-1138.

Bock, O (1997) Effects of a tilted visual background on human sensory-motor coordination. Experimental Brain Research, 115, 507-512.

Bruin, KJ, Kenemans, JL, Verbaten, MN and Vanderheijden, AHC (1997) Localization of early visual processing and effects of spatial attention. Journal of Psychophysiology, 11, 91-91.

Buckley, MJ and Gaffan, D (1997) Impairment of visual object-discrimination learning after perirhinal cortex ablation. Behavioral Neuroscience, 111, 467-475.

Budde, WM, Korth, M and Mardin, CY (1997) Large-field s-cone flicker test. Graefes Archive for Clinical and Experimental Ophthalmology, 235, 415-424.

Carreiras, M, Perea, M and Grainger, J (1997) Effects of orthographic neighborhood in visual word recognition: cross-task comparisons. Journal of Experimental Psychology-Learning Memory and Cognition, 23, 857-871.

Chan, HS and Courtney, AJ (1997) Visual performance on synchronous and asynchronous peripheral target detection tasks. Human Factors and Ergonomics in Manufacturing, 7, 197-210.

Chung, STL and Bedell, HE (1997) Congenital nystagmus image motion: influence on visual acuity at different luminances. Optometry and Vision Science, 74, 266-272.

Clarke, MP, Mitchell, KW and Gibson, M (1997) The prognostic value of flash visual evoked potentials in the assessment of non-ocular visual impairment in infancy. Eye, 11, 398-402.

Cowey, A and Stoerig, P (1997) Visual detection in monkeys with blindsight. Neuropsychologia, 35, 929-939.

Dorais, A and Sagi, D (1997) Contrast masking effects change with practice. Vision Research, 37, 1725-1733.

Durgin, FH and Wolfe, SE (1997) Global precedence in visual search? not so fast: evidence instead for an oblique effect. Perception, 26, 321-332.

Engel, S, Zhang, XM and Wandell, B (1997) Colour tuning in human visual cortex measured with functional magnetic resonance imaging. Nature, 388, 68-71.

Erkelens, CJ and Vanee, R (1997) Capture of the visual direction of monocular objects by adjacent binocular objects. Vision Research, 37, 1735-1745.

Fermuller, C, Pless, R and Aloimonos, Y (1997) Families of stationary patterns producing illusory movement: insights into the visual system. Proceedings of the Royal Society of London Series B-Biological Sciences, 264, 795-806.

Fernandez, X (1997) Template matching of binary targets in grey-scale images: a nonparametric approach. Pattern Recognition, 30, 1175-1182.

Fischl, B, Cohen, MA and Schwartz, EL (1997) The local structure of space-variant images. Neural Networks, 10, 815-831.

Gegenfurtner, KR (1997) Visual neurobiology - colouring the cortex. Nature, 388, 23-24.

Ghosal, S and Mehrotra, R (1997) A moment-based unified approach to image feature detection. IEEE Transactions on Image Processing, 6, 781-793.

Gray, R and Regan, D (1997) Vernier step acuity and bisection acuity for texture-defined form. Vision Research, 37, 1713-1723.

Grossberg, S (1997) Cortical dynamics of three-dimensional figure-ground perception of two-dimensional pictures. Psychological Review, 104, 618-658.

He, Y, Rea, M, Bierman, A and Bullough, J (1997) Evaluating light source efficacy under mesopic conditions using reaction times. Journal of the Illuminating Engineering Society, 26, 125.

Heller, J (1997) On the psychophysics of binocular space perception. Journal of Mathematical Psychology, 41, 29-43.

Hoffmann, A (1997) Using a high-resolution display for screening visual acuity for near vision. Displays, 18, 11-19.

Horberry, TJ, Gale, AG and Taylor, SP (1997) Vision screeners for display screen equipment users: an experimental evaluation. Displays, 17, 111-117.

Hovis, JK (1997) Long wavelength pass filters designed for the management of color vision deficiencies. Optometry and Vision Science, 74, 222-230.

Hubel, DH (1997) Vision in dim light. Nature, 388, 32-33.

Hurlbert, A (1997) Primer - colour vision. Current biology, 7, R400-R402.

Inoue, T and Ohzu, H (1997) Accommodative responses to stereoscopic three-dimensional display. Applied Optics, 36, 4509-4515.

Jaschinski, W (1997) Fixation disparity and accommodation as a function of viewing distance and prism load. Ophthalmic and Physiological Optics, 17, 324-339.

Jobson, DJ, Rahman, ZU and Woodell, GA (1997) A multiscale retinex for bridging the gap between color images and the human observation of scenes. IEEE Transactions on Image Processing, 6, 965-976.

Kaminski, HJ and Leigh, RJ (1997) International symposium for therapy of ocular motility and related visual disturbances. Neurology, 48, 1178-1184.

Kappers, AML, Koenderink, JJ and Oudenaarden, G (1997) Large scale differences between haptic and visual judgments of curvature. Perception, 26, 313-320.

Kasten, E, Strasburger, H and Sabel, BA (1997) Programs for diagnosis and therapy of visual field deficits in vision rehabilitation. Spatial Vision, 10, 499-503.

Kuehni, RG (1997) Memoir concerning certain phenomena of vision - commentary and translation. Color Research and Application, 22, 199-200.

Kulikowski, JJ, Mckeefry, DJ and Robson, AG (1997) Selective stimulation of colour mechanisms: an empirical perspective. Spatial Vision, 10, 379-402.

Lee, B and Rogers, B (1997) Disparity modulation sensitivity for narrow-band-filtered stereograms. Vision Research, 37, 1769-1777.

Legge, GE, Ahn, SJ, Klitz, TS and Luebker, A (1997) Psychophysics of reading .16. the visual span in normal and low vision. Vision Research, 37, 1999-2010.

Legge, GE, Klitz, TS and Tjan, BS (1997) Mr chips: an ideal-observer model of reading. Psychological Review, 104, 524-553.

Levi, DM, Polat, U and Hu, YS (1997) Improvement in vernier acuity in adults with amblyopia - practice makes better. Investigative Ophthalmology & Visual Science, 38, 1493-1510.

Lithander, J (1997) Visual development in healthy eyes from 24 months to four years of age. Acta Ophthalmologica Scandinavica, 75, 275-276.

Luck, SJ, Girelli, M, Mcdermott, MT and Ford, MA (1997) Bridging the gap between monkey neurophysiology and human perception: an ambiguity resolution theory of visual selective attention. Cognitive Psychology, 33, 64-87.

Luque, MJ, Capilla, P, Felipe, A and Artigas, JM (1997) Brightness induction in a chromatic center - achromatic surround configuration. Color Research and Application, 22, 228-239.

Mansfield, JS and Legge, GE (1997) Binocular visual direction, the cyclopean eye, and vergence: reply Banks, van Ee and Backus (1997). Vision Research, 37, 1610-1613.

Mareschal, I, Ashida, H, Bex, PJ, Nishida, S and Verstraten, FAJ (1997) Linking lower and higher stages of motion processing? Vision Research, 37, 1755-1759.

Martin, PR, White, AJR, Goodchild, AK, Wilder, HD and Sefton, AE (1997) Evidence that blue-on cells are part of the third geniculocortical pathway in primates. European Journal of Neuroscience, 9, 1536-1541.

Martinezverdu, F, Luque, MJ, Malo, J, Felipe, A and Artigas, JM (1997) Implementations of a novel algorithm for colour constancy. Vision Research, 37, 1829-1844.

May, CA (1997) Special article - description and function of the ciliary nerves - some historical remarks on choroidal innervation. Experimental Eye Research, 65, 1-5.

Monge, M (1997) Classical articles in color - memoir concerning certain phenomena of vision. Color Research and Application, 22, 200-203.

Morris, JS, Friston, KJ and Dolan, RJ (1997) Neural responses to salient visual stimuli. Proceedings of the Royal Society of London Series B-Biological Sciences, 264, 769-775.

Murdoch, IE, Jones, BR, Cousens, S, Liman, I, Babalola, OE and Dauda, J (1997) Visual field constriction as a cause of blindness or visual impairment. Bulletin of the World Health Organization, 75, 141-146.

Ohzawa, I, Deangelis, GC and Freeman, RD (1997) Encoding of binocular disparity by complex cells in the cat's visual cortex. Journal of Neurophysiology, 77, 2879-2909.

Pankow, L and Luchins, D (1997) An optical intervention for visual hallucinations associated with visual impairment in an elderly patient. Optometry and Vision Science, 74, 138-143.

Patterson, R (1997) Visual processing of depth information in stereoscopic displays. Displays, 17, 69-74.

Polack, JA, Piegl, LA and Carter, ML (1997) Perception of images using cylindrical mapping. Visual Computer, 13, 155-167.

Porciatti, V, Dibartolo, E, Nardi, M and Fiorentini, A (1997) Responses to chromatic and luminance contrast in glaucoma: a psychophysical and electrophysiological study. Vision Research, 37, 1975-1987.

Purves, D and Andrews, TJ (1997) The perception of transparent three-dimensional objects. Proceedings of the National Academy of Sciences of the United States of America, 94, 6517-6522.

Qian, N and Andersen, RA (1997) A physiological model for motion-stereo integration and a unified explanation of pulfrich-like phenomena. Vision Research, 37, 1683-1698.

Qian, N and Zhu, YD (1997) Physiological computation of binocular disparity. Vision Research, 37, 1811-1827.

Raasch, T (1997) Clinical refraction in three-dimensional dioptric space revisited. Optometry and Vision Science, 74, 376-380.

Rasengane, TA, Allen, D and Manny, RE (1997) Development of temporal contrast sensitivity in human infants. Vision Research, 37, 1747-1754.

Rosblad, B (1997) Roles of visual information for control of reaching movements in children. Journal of Motor Behavior, 29, 174-182.

Sakata, H, Taira, M, Kusunoki, M, Murata, A and Tanaka, Y (1997) The tins lecture - the parietal association cortex in depth perception and visual control of hand action. Trends in Neurosciences, 20, 350-357.

Salinas, E and Abbott, LF (1997) Invariant visual responses from attentional gain fields. Journal of Neurophysiology, 77, 3267-3272.

Sample, PA, Irak, I, Martinez, GA and Yamagishi, N (1997) Asymmetries in the normal short-wavelength visual field: implications for short-wavelength automated perimetry. American Journal of Ophthalmology, 124, 46-52.

Sanocki, E, Teller, DY and Deeb, SS (1997) Rayleigh match ranges of red/green color-deficient observers: psychophysical and molecular studies. Vision Research, 37, 1897-1907.

Shimojo, S, Miyauchi, S and Hikosaka, O (1997) Visual motion sensation yielded by non-visually driven attention. Vision Research, 37, 1575-1580.

Shufelt, JA (1997) Texture analysis for enhanced color image quantization. Graphical Models and Image Processing, 59, 149-163.

Spinelli, D, Angelelli, P, Deluca, M, Dipace, E, Judica, A and Zoccolotti, P (1997) Developmental surface dyslexia is not associated with deficits in the transient visual system. Neuroreport, 8, 1807-1812.

Strasburger, H (1997) Use of computers and cathode-ray-tube displays in visual psychophysics .1. Spatial Vision, 10, 301-304.

Stuart, GW, Maruff, P and Currie, J (1997) Object-based visual attention in luminance increment detection? Neuropsychologia, 35, 843-853.

Swindale, NV (1997) Visual cortex: a cat's-eye view of the visual system. Current Biology, 7, R387-R389.

Syrkin, G and Gur, M (1997) Colour and luminance interact to improve pattern recognition. Perception, 26, 127-140.

Thornton, WA (1997) Toward a more accurate and extensible colorimetry .4. visual experiments with bright fields and both 10 degrees and 1.3 degrees field sizes. Color Research and Application, 22, 189-198.

Tomaiuolo, F, Ptito, M, Marzi, CA, Paus, T and Ptito, A (1997) Blindsight in hemispherectomized patients as revealed by spatial summation across the vertical meridian. Brain, 120, 795-803.

Travis, D and Stewart, T (1997) Statistical methods for testing the visual quality of displays. Displays, 18, 29-36.

Tweed, D (1997) Visual-motor optimization in binocular control. Vision Research, 37, 1939-1951.

Vandenbosch, ME and Wall, M (1997) Visual acuity scored by the letter-by-letter or probit methods has lower retest variability than the line assignment method. Eye, 11, 411-417.

Vandonkelaar, P (1997) Eye-hand interactions during goal-directed pointing movements. Neuroreport, 8, 2139-2142.

Wase, MG and Jones, G (1997) The role of vision and spatial orientation in the maintenance of posture. Physical Therapy, 77, 619-628.

Yamaguchi, T, Motulsky, AG and Deeb, SS (1997) Visual pigment gene structure and expression in human retinae. Human molecular genetics, 6, 981-990.

Yang, J and Makous, W (1997) Implicit masking constrained by spatial inhomogeneities. Vision Research, 37, 1917-1927.

Yao, LJ and Peck, CK (1997) Saccadic eye movements to visual and auditory targets. Experimental brain research, 115, 25-34.

Zanker, JM (1997) Is facilitation responsible for the "motion induction" effect? Vision Research, 37, 1953-1959.

Zanker, JM (1997) Second-order motion perception in the peripheral visual field. Journal of the Optical Society of America A-Optics Image Science and Vision, 14, 1385-1392.

Zetzsche, C, Barth, E, Krieger, G and Wegmann, B (1997) Neural network models and the visual cortex: the missing link between orientation selectivity and the natural environment. Neuroscience Letters, 228, 155-158.

Zhao, DM and Zhang, XT (1997) Range-data-based object surface segmentation via edges and critical points. IEEE Transactions on Image Processing, 6, 826-830.

References supplied (as usual!) by:

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Meetings Calendar

1997

September 4	*AVA meeting on depth perception.* University of Surrey. email: M.Bradshaw@surrey.ac.uk
September 14-17	*Vision in Vehicles 7*, Marseilles, France. Contact: 01332-622287, email: avru@derby.ac.uk
November 5	*AVA postgraduate meeting.* College of Optometrists, London. Contact: 0171 373 7765
November 19-20	Brain mechanisms of selective perception and action. The Royal Society, London. http://www.royalsoc.ac.uk/rs/

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January 7	Colour Group Vision Meeting Institute of Ophthalmology http://www.city.ac.uk/colourgroup/
May 10-15	ARVO, Ft Lauderdale, USA Abstract deadline: 5 December 1997 http://www.faseb.org/arvo/