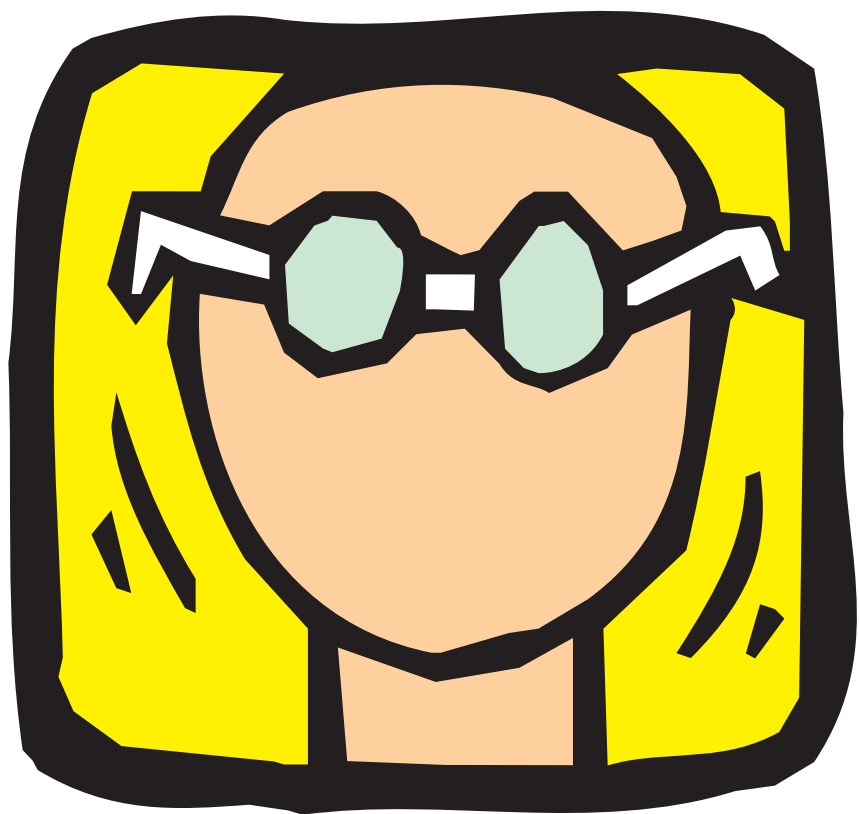


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*Bulletin of the
Applied Vision
Association*



AVA Christmas Meeting abstracts: Aston
Geoffrey J. Burton Award
Call for papers: Postgraduate meeting
References on Vision

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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 Internet

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.

There is also an AVA anonymous ftp site at: *<ftp://hc.les.dmu.ac.uk>* containing a hyperspectral data set of natural scenes produced by Gavin Brelstaff (see <http://www.crs4.it/~gjb/ftpJOSA.html>). If there is anything else you think this archive should contain then let us know.

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

The College of Optometrists has moved! All AVA correspondence should now be sent to 42 Craven Street, London. In this issue of the Bulletin we have a report from Nick Scott-Samuel who was awarded the Geoffrey Burton memorial prize. There are also details of changes to this scheme so awards will now be made once a year and the amount of the award increased to £400. The Bulletin contains the abstracts of the AVA Christmas meeting held at Aston and also details of the forthcoming postgraduate meeting to be held at the College of Optometrists.

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 February 1998

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 £400.

The AVA Committee has decided that from now on there will be a single award made once a year. The closing date for awards will be on 28th February each year and will be for conferences held from 1st March to the following 28th February (ie there will not be retrospective awards). Applicants do not have to be presenting at an AVA conference.

The next closing date for applications is:

28th February 1998

for conferences held between 1st March 1998 and 28th February 1999.

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

The AVA Secretariat,
College of Optometrists,
42 Craven Street,
London,
WC2N 5NG.

The award for nominations closing on 31st August 1997 went to:

Nick Scott-Samuel, Royal Holloway

who was awarded £175 for his presentation entitled:
"Motion contrast: a new metric for direct discrimination"
that was presented at the ECVP in Finland in August 1997.

Report of ECVF meeting, Helsinki, September 1997

The Applied Vision Association awarded me a Geoffrey J Burton Memorial Fund travel bursary to attend the European Conference on Visual Perception held in Helsinki, Finland in September 1997. Of particular interest to me were the motion sessions (paper and poster), the symposia on “Progress and Paradigm Shifts in Vision Research during the 20 years of ECVF” and “Brain Imaging”, and the Sensitivity and Contrast” and Binocularity and Stereopsis” and paper sessions.

My poster presentation, “Motion contrast: a new metric for direction discrimination”, was well received. It dealt with some modifications to the Adelson-Bergen motion energy model (1985, *Journal of the Optical Society of America A*, 2, 284-299), designed to take account of Heeger’s suggestion that divisive inhibition amongst straight cells requires the addition of contrast gain control to the model (1992, *Visual Neuroscience*, 9, 181-197). The predictions of the modified energy model were confirmed psychophysically.

The strong international presence at the conference resulted in much helpful feedback. In particular, I had the chance to discuss the poster with Ted Adelson. He was very positive about the work, and didn’t seem to mind my explaining the basics of the Adelson-Bergen energy model to him at some length before he revealed his identity (people really should wear their name badges).

After the conference, I gave an invited talk at the Department of Clinical Neurophysiology, University of Kuopio, Finland, entitled “Two stimulus sequences: moving strips and a missing fundamental in depth”, as part of a mini symposium on motion. Again I received helpful feedback from the other participants, and found the other presentations most interesting.

Nick Scott-Samuel

Motion contrast: a new metric for direction discrimination

N.E. Scott-Samuel* and M.A Georgeson

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The Adelson-Bergen energy model (1985 Journal of the Optical Society of America A 2 284-299) is a standard framework for understanding 1st-order motion processing. Its output, the opponent energy for a given output is calculated by subtracting one directional energy measure (L) from its opposite (R), and its sign indicates the direction of the motion of the input. Our observers viewed a dynamic sequence of gratings (1 c/deg) equivalent to the sum of the two grating movings in the opposite directions with different contrasts, and had to report the dominant direction of motion. The ratio of contrasts was varied across trials. We found the opponent energy was a very poor predictor of direction discrimination performance. Heeger (1992 Visual Neuroscience 9, 181-197) has suggested the divisive inhibition amongst striate cells requires a contrast gain control in the energy model. A new metric can be formulated in the spirit of Heeger's model by normalising the opponent energy (L-R) with a flicker energy, the sum of the directional motion energies (L + R). This new measure, motion contrast $(L-R)/(L+R)$, was found to be a good predictor of direction discrimination performance over a wide range of contrast levels, but opponent energy was not. Discrimination thresholds expressed as motion contrast were around 0.5 for the sampled drifting gratings used in our experiments, corresponding to an energy ratio (L:R or R:L) of 3:1 at discrimination threshold. Such high values suggest that the outputs of motion energy filters are very noisy (variable over space and time) or that the use of them is inefficient.

***Applied Vision Association
The Second
Christmas Meeting.***

T H E V I S U A L B R A I N

Wednesday 17th December
Aston University

Meeting abstracts

These abstracts can be viewed on the internet at the following address:

<http://www.dmu.ac.uk/ava/ast97-ab.html>

Directionality, asymmetry, and infancy

O Braddick (Psychology Dept, University College London, Gower Street, London WC1E 6BT, UK; e-mail: ucjtsol@ucl.ac.uk)

Directional motion sensitivity is a pervasive feature of visual systems and a key element in many of the ways we use vision. However, in human development, behavioural directional discriminations and directionally-specific VEPs emerge later in infancy than sensitivity to static orientation. Possible neurobiological reasons for this sequence will be discussed.

The postnatal emergence of these directional functions needs to be reconciled with the presence from birth of optokinetic nystagmus (OKN) which also depends on directional selectivity. OKN in the newborn has a characteristic signature of monocular asymmetry: for each eye, temporal-to-nasal stimulus motion is much more effective than nasal-to-temporal. This asymmetry has been taken as evidence for an early, purely subcortical mechanism which cannot subserve cortical uses of motion information. Against this view is evidence from unilateral cerebral damage and from VEP responses, presumably cortical, which share this asymmetric signature. New findings from our laboratory show that the VEP and

OKN asymmetries are not so simply related as has been supposed. Multiple directional motion systems interact in development, but understanding this interaction remains a challenge.

No 2nd-order input to optic flow perception

P J Bex, D R Simmons¶, I Mareschal# (Dept of Psychology, University of Glasgow, Florentine House, Hillhead Street, Glasgow G12 8QB, UK; ¶ Dept of Vision, Glasgow Caledonian University, City Campus, Cowcaddens Road, Glasgow G4 0BA, UK; #McGill Vision Research Centre, 687 Pine Avenue West, H 4-14, Montreal, Quebec, Canada H3A 1A1; fax: +44 141 339 8889; e-mail: bex@psy.gla.ac.uk)

Growing psychophysical and physiological evidence supports hierarchical models of motion processing in which local velocity signals are assembled to form receptive fields specialised for optic flow components. For example, the equality of detection and identification thresholds for both radiation and rotation (Gurney and Wright, 1996 *Perception* **25** 5) requires the existence of labelled detectors for these patterns, and radiation looks faster than translation composed of identical local speeds (Bex and Makous, 1997 *Vision Research* in press) implicating two-stage analysis. We inspected 4 micropatterns that formed complex global configurations: whereas 1st-order micropatterns appeared as a single moving object viewed through 4 apertures, there was no such global coherence of 2nd-order micropatterns. This observation prompted a quantitative study of the contribution of 2nd-order motion to optic flow. Detection, identification and direction discrimination thresholds were measured for 1st- and 2nd-order patterns (sinusoidal contrast modulation of static and dynamic noise) of translatory, rotatory and radial motion comprising 4 local micropatterns identical except for orientation. The perceived speed of rotation and radiation was also matched to that of translation. For 1st-order patterns the results confirmed the equality of thresholds and that radiation looked faster than translation or rotation. For 2nd-order stimuli, direction discrimination thresholds were much higher than identification or detection thresholds and all patterns appeared to move at the same speed. The results provide no evidence for labelled detectors for 2nd-order rotation and radiation and suggest that there is no 2nd-order input to the perception of optic flow.

Temporal effects of attention on motion sensitivity

J E Raymond, H L O'Donnell, S P Tipper (School of Psychology, University of Wales, Bangor LL57 2DG, UK; e-mail: pss117@bangor.ac.uk)

Attention studies show that visual selection of a target can have a long lasting effect on identification of a subsequently presented second target. Can temporal effects of selection affect *sensitivity* to simple features and thereby provide an account for simple successive stimulus interactions? After viewing a brief (200 ms) episode of, say, rightward motion, observers are markedly less sensitive to rightwards motion and more sensitive to leftward motion in a second episode presented a short time later. We investigated attentional modulation of this successive stimulus interaction using a dual-task priming/adaptation paradigm. We asked healthy adults to select one direction from a briefly presented dynamic random dot display containing two orthogonal and transparent directions and then to judge the direction of motion in a second dot display containing a single direction presented after a brief interval. The coherence of the second display was varied. The interval between the two episodes was also varied. We found large losses in sensitivity to previously selected directions combined with enhanced sensitivity to previously ignored directions. There was no change in sensitivity for directions opposite to either previously seen directions. These effects can not be explained by notions of motion opponency or low-level data-driven sensory adaptation. They indicate that temporal effects of attention can dramatically alter sensitivity to simple stimulus features and provide a reasonable account for successive direction contrast effects.

Modelling biological motion analysis in terms of image flow

A Johnston, P W McOwan¶ (Department of Psychology, University College London, Gower Street, London WC1E 6BT, UK; ¶ and Department of Cybernetics, University of Reading, Reading, UK; fax: +44 171 436 4276; e-mail: a.johnston@ucl.ac.uk)

Models of biological motion analysis are typically based on correspondence matches between separate frames of an image sequence, detection of spatio-temporal orientation by matched filters (motion energy analysis) or the orientation of spatio-temporal image gradients. Here we consider an alternative approach based on the computation of image flow over segments of boundaries in the image. As a two dimensional spatial image moves over a boundary segment, it develops a spatio-temporal image which

contains a history of the flow over the boundary. Integrating over this spatio-temporal region gives the total flow over the segment in a given temporal interval. We can also calculate the difference in the amount of light within the region at the beginning and end of the interval. Assuming conservation of the image brightness we can calculate the speed and direction of motion from the change in the image brightness over the interval and the various flows across segments of the boundary of the region in the image. Consideration is given to how this strategy might be implemented in the human and primate visual systems.

Supported by the BBSRC/EPSRC Mathematical Biology Initiative.

Spatial segregation and the perception of motion

J Harris (Department of Psychology, University of Reading, Whiteknights, Reading RG6 6AL, UK; e-mail: J.P.Harris@reading.ac.uk)

How does the visual system allocate motion to different regions of the retinal image? The role of spatial information in this process was studied by measuring the strength of the motion aftereffect (by ratings of initial strength and timing of duration), produced by a standard adaptation regime, on a test window (with central fixation point) of previously moving stationary vertical test stripes, as a function of their relationship with stationary vertical surrounding stripes. In Experiment 1, it was found that MAEs were stronger and more durable when the test stripes were offset by 90 deg than when they were perfectly aligned with the surrounding stripes. This effect of offset was stronger than the effect of surrounding the window with a border. In Experiment 2, test stripe offset was varied systematically. MAE strength and duration rose with test stripe offset up to 72 deg, the largest offset between 0 and 180 deg used in this experiment. Although the MAE, on both measures, was reduced when offset was further increased to 180 deg (white stripes aligned with black), it was still higher at that offset than for 0 deg offset (white stripes aligned with white). In contrast, in a separate condition with no prior adaptation to motion, when subjects were asked to rate how separate the test windows appeared from the surround, ratings rose with offset not only up to 72 but then further up to 180 deg. In Experiment 3, which probed the range of offsets between 72 and 180 deg, segregation ratings were again higher for 180 than for 90 deg, but peaked at 166 deg offset, whereas MAE strength peaked at 72 deg offset. In summary, both MAE strength and judged segregation vary with the relationship between the test stripes and the surround. However, the former appears to depend more on size of offset

or phase shift between the test and surrounding stripes, whereas the latter appears to depend more on the length of black/white border at the edge of the test window.

The quantized degrees-of-freedom in images and visual codes

J Daugman (The Computer Laboratory, University of Cambridge, Cambridge CB2 3QG, UK; e-mail: john.daugman@CL.cam.ac.uk)

Several classical results in signal processing and information theory can be summarized by the statement that the information contained in continuous, bandlimited signals (such as images) is in fact quantized. Despite the apparent denseness of such signals, the information they contain can be completely enumerated as a countable list of “quanta”. Five familiar examples which have influenced the visual sciences are:

1. Nyquist’s (1911) Sampling Theorem: A continuous, bandlimited signal can be completely represented by a discrete set of samples.
2. Hartley’s (1928) principle: The number of degrees-of-freedom in a signal of duration T and bandwidth W is at most $2WT$.
3. Gabor’s (1946) logons: The information diagram for a signal has a quantal grain structure, whose smallest “atoms” of independent data define a non-orthogonal expansion basis using complex-valued wavelets.
4. Shannon’s (1948) Channel Coding Theorem: A continuous communication channel can transmit continuous information at a maximum rate (as measured in bits/second) specified by, among other things, its signal-to-noise ratio.
5. Logan’s (1977) Theorem: For bandpass signals whose bandwidth is no greater than one octave, their zero-crossings alone (a finite set of points) completely specify the waveform (excluding AM signals) up to a scale factor.

In addition to these classical coding insights, strongly nonlinear ideas such as vector quantization (VQ) exploit the fact that only a tiny fraction of possible image structures actually do occur in real images, so it is more efficient simply to nominate the types that do occur (by matching to a finite discrete codebook) than to code for all possible ones. For the visual sciences, the legacy and influence of these insights about quantized degrees-of-freedom extend to: optical quality in relation to retinal sampling; understanding 2-D receptive field profiles; limits of perceptual uptake; explanations of illusions and isomeres; and modelling the efficiency of visual codes in terms of image compression and recognition. The above family of classical results will be briefly reviewed and applied to a

contemporary problem in pattern recognition and computer vision, in which high-confidence visual recognitions of personal identity are achieved in real time simply by detecting a failure of statistical independence in mathematically encoded iris patterns. The decision environments created thereby have a decidability (or detectability, d') index exceeding 11.

Visual perception and the higher-order structure of psychophysical stimuli.

M G A Thomson (Vision Sciences, Aston University, Birmingham B4 7ET, UK; fax: +44 121 333 4220; e-mail: M.G.A.Thomson@aston.ac.uk)

One of the goals of visual psychophysics is to determine a representation which relates the perceptually significant structure of visual stimuli to their physical properties. A useful representation would work equally well for both classical experimental stimuli (bars, gratings, etc.) and 'natural' stimuli but has so far proved elusive. For example, there has been much debate over the relative importance of low and high spatial frequencies in bar detection/perception, and the roles of Fourier amplitude, phase and orientation in natural-image perception/discrimination are still unclear. Higher-order statistical image measures have, however, met with some success in predicting psychophysical results for both classical (Klein and Tyler, 1986 *Journal of the Optical Society of America A* **3** 868-879) and natural (Thomson and Foster, 1997 *Journal of the Optical Society of America A* **14** 2081-2090) visual stimuli. The work reported here considered third-order statistics: this is the lowest-order global measure sensitive to both amplitude and relative phase. Computational techniques such as phase randomization, phase quantization, and phase-amplitude hybridization were used to distort a variety of classical and natural psychophysical stimuli. The visual appearance of these distorted stimuli was then related to changes in their third-order structure. The results illustrate the potential value of adopting these higher-order physical measures and will be discussed in terms of likely sensory representations.

How amblyopic vision uses phase and amplitude information in natural images

C A Parraga, G M Kennedy, D J Tolhurst (Department of Physiology, Downing Street, Cambridge, CB2 3EG, UK; e-mail: djt12@cam.ac.uk)

As many as 5% of the population may suffer from *amblyopia*, a condition in which vision is impaired in one eye without obvious pathologies of the eye or visual pathways and cannot be corrected by refractive means. Unfortunately, simple laboratory or clinical tests of visual performance may not always reflect the full nature of this disability. Our objective was to identify the real extent of the visual disability of amblyopia using stimuli related to everyday visual tasks. A modified two-alternative forced-choice experiment was used to measure sensitivity to changes in natural images caused by systematic perturbations of the phases or amplitudes of the coefficients in their Fourier spectra (Tadmor and Tolhurst, 1994 *Vision Research* **34** 541-554; Thomson and Foster, 1995 *Journal of Physiology* **485P** 25P). Experiments were performed on amblyopic subjects using one eye at a time. Subjects had to discriminate between test images made by gradually exchanging the phase spectra between two different natural images (5 subjects) or by gradually randomising the phase spectrum (7 different subjects). Both kinds of *phase* perturbation were much less easily detected when the amblyopic eye was used than when the good eye was used. These effects were equally pronounced when the subject has to discriminate between images with different Fourier *amplitude* spectra (the second 7 subjects).

Supported by *Fight for Sight*.

Simplifying images

L D Griffin (Vision Sciences, Aston University, Birmingham, B4 7ET, UK; fax: +44 121 333 4220; e-mail: l.d.griffin@aston.ac.uk)

Many schemes for simplifying images have been proposed; the most notable, based on progressive Gaussian blurring, may be achieved either by 'viewing' the image through apertures of increasing size or by running the diffusion equation $L = L + L$ (where the subscripts indicated differentiation with respect to time t^{xx} and position x, y). Other simplification schemes can be cast only in the equational form and not in the aperture form. For example, mean curvature flow (MCF) simplifies an image by

moving isophotes at a speed proportional to their curvature; in equational form, $L = L - v \frac{\partial L}{\partial v}$ where v is in the direction tangent to the isophote. Recently, Guichard and Morel (1996 *Ceremade Technical Report #9335*) proved that MCF could be cast as an aperture scheme but only if the apertures were of infinitesimal size and applied iteratively to progressively simplify the image. They proved that MCF is equivalent to iterated infinitesimal (i.i.) median filtering and they noted the parallel with the well-known fact that Gaussian blurring is equivalent to i.i. mean filtering. This suggested a generalization that has now been proved: i.i. mode filtering is equivalent to the evolution scheme $L = L - 2L \frac{\partial L}{\partial w}$ (where the v is as before and w is in the gradient direction). With i.i. mode filtering, unlike i.i. mean filtering or i.i. median filtering, the image stops changing before it becomes constant-valued: instead, the endpoint is a mosaic of constant regions separated by discontinuities. This result may explain why a similar formula, $L = L - 3L \frac{\partial L}{\partial w}$, proposed by Gabor (1965 *Laboratory Investigations* 14 801-807) is image-enhancing.

Automatic face representation for unfamiliar-view face recognition

D B Graham, N M Allinson (Dept of Electrical Engineering and Electronics, UMIST, Sackville Street, PO Box 88, Manchester, M60 1QD, UK; fax: +44 161 200 4673; e-mail: danny@sound.ee.ac.uk)

Experiments have shown that there are viewpoint dependencies which affect the nature of human face recognition. These dependencies support the model that humans represent faces as a set of 2D images which are interpolated between and extrapolated beyond during the recognition process. As faces belong to a specific class of objects we can use our prior knowledge of facial structure to facilitate this interpolation and extrapolation.

This paper describes an eigenspace manifold for the automatic representation and recognition of pose-varying faces. We show that the distribution of faces in this manifold allows us to determine an efficient representation which we can then use to characterise faces in the manifold. Faces are characterised by estimating their appearance at novel viewpoints using knowledge gained from other faces undergoing the same change. We show how the degree of representation affects recognition performance and contrast these results with previous results obtained using the same characterisation with a manual representation.

Finally we draw parallels between our system and reported human behaviour including some neurophysiological evidence for view-specific face representation.

Multiple orientation-selective mechanisms for line-target detection

D H Foster, S Westland¶ (Vision Sciences, Aston University, Birmingham, B4 7ET, UK; ¶ Department of Communication and Neuroscience, Keele University, Staffordshire ST5 5BG, UK; fax: +44 121 333 4220; e-mail: D.H.Foster@aston.ac.uk)

Observers can detect a line element differing in orientation from a background of uniformly oriented line elements rapidly and effortlessly. This kind of efficient target detection is thought to involve the early or preattentive stages of visual processing (Treisman, 1985 *Computer Vision, Graphics, and Image Processing* **31** 156-177). The level of performance depends both on the angle between the target and background elements and on the orientations of the background elements themselves (Foster and Ward, 1991 *Proceedings of the Royal Society of London B* **243** 75-81). In an extended psychophysical study, threshold values of the angle between target and background elements were obtained as a function of the orientation of the background elements. An analysis of these threshold functions suggested the involvement of distinct groups of orientation-selective mechanisms: coarse- and medium-scale mechanisms whose preferred orientations were spaced on average at angles of about 90 deg and 35-50 deg respectively in the frontoparallel plane, and which had common alignments over observers; and also fine-scale mechanisms whose preferred orientations were spaced on average at angles of 10-25 deg, but whose alignments varied randomly from observer to observer, possibly reflecting individual variations in neuronal sampling characteristics. Increasing effective display duration produced a shift in activity from coarser- to finer-scale mechanisms, a result consistent with the notion that the visual system applies a process of limited refinement in detecting the orientations of lines in scenes.

Orientalional anisotropy in line-target detection with and without a gravitational reference for orientation

L M Doherty, D H Foster (Vision Sciences, Aston University, Birmingham, B4 7ET, UK; fax: +44 121 333 4220; e-mail: dohertlm@aston.ac.uk)

When observers detect a uniquely oriented line element ('target') among uniformly oriented line elements ('nontargets'), detection performance depends on element orientation (Treisman and Gormican, 1988 *Psychological Review* **95** 15-48; Foster and Ward, 1991 *Proceedings of the Royal Society of London B* **243** 75-81). When displays of line elements are presented briefly, the orientation increment threshold (the difference between nontarget and target orientations that is required for effective detection) is generally lower with vertical or horizontal nontargets than with tilted nontargets. Thus, the variation of orientation increment threshold with nontarget orientation is periodic with a period of about 90 deg. Does this orientational anisotropy depend on the observer's use of the direction of gravity as a reference for orientation? In an experiment to address this question, observers viewed briefly presented displays of line elements while sitting (so that gravity could be used as a cue defining the vertical in stimulus displays) and while supine (lying horizontally, face upwards, so that gravity provided no such cue). Twenty line elements of length 1 deg visual angle were presented in a circular field of diameter 20 deg visual angle. Nontarget orientations were in the range 0, 5, ..., 175 deg from the vertical. The difference between nontarget and target orientations was varied adaptively. Stimulus displays lasting 40 ms were followed by a blank interstimulus interval lasting 180 ms or less and then a random-line mask. With both sitting and supine observers, orientational anisotropy in thresholds was found. So, it appears that the orientational reference frame for early visual processing can be defined without gravitational information, by retinocentric coding or by awareness of the body axis.

Grouping by proximity or similarity?: competition between the Gestalt principles in vision.

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This paper examines the nature of the psychological processes that

underlie the Gestalt principles of grouping by proximity and grouping by similarity. Similarity was defined relative to the principles of grouping by common colour and grouping by common shape. Subjects were presented with displays comprising a row of seven coloured shapes and were asked to rate the degree to which the central target shape grouped with either the right or left flanking shapes. Across the displays the proximal and featural relationships between the target and flankers were varied.

These ratings reflected persuasive effects of grouping by proximity and common colour: there was only weak evidence for grouping by common shape. Nevertheless, both common colour and common shape were shown to over-ride grouping by proximity, under certain conditions. The data also show that to understand how the Gestalt principles operate, it appears necessary to consider processes that operate within and between groups of elements that are initially identified on the basis of proximity. Whether such groups survive further analysis depends critically on the featural content of the constituent elements.

The spatial frequency tuning of visual contour integration

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This paper examines the mechanism subserving visual contour detection and particularly its tuning for the spatial frequency of contour components. We measured the detection of contours composed of Gabor micro-patterns within a field of randomly oriented distractor elements. Distractors were randomly assigned one of two spatial frequencies and elements lying along the contour alternated between these values. We report that the degree of tolerable spatial frequency difference between successive contour elements is inversely proportional to the orientation difference between them. Spatial frequency tuning (half-width at half-height) for straight contours is around 1.3 octaves but, for contours with a 30° difference between successive elements, drops to around 0.7 octaves. Integration of curved contours appears to operate at a narrower bandwidth. Much orientation information in natural images arises from edges, and we propose that this narrowing of tuning is related to the reduction in inter-scale “support” that accompanies increasing edge curvature.

Contributions of parvo- and magno-signals to cortical responses: selectivity limits.

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In a series of studies we have established that low-contrast, low-spatial-frequency gratings selectively activate parvo/magno streams. Responses to the onset of chromatic (isoluminant) gratings are sustained and parvo-like, whereas responses to coarse achromatic (luminance modulated) gratings are transient and magno-like. In this study we further investigate the contrast-dependence of selective stimuli by comparing human visual evoked potentials (VEPs) with VEPs, field potentials, multi-unit and single unit activity (in macaque monkey).

Comparison of VEP responses to a grating presented on-off and reversed in contrast can provide an index of parvo/magno involvement: responses to low chromatic contrast are sustained, but at higher contrast transient components are generated. Isoluminant stimuli can elicit transient-type field potentials which represent residual magno activity. Conversely, the higher the achromatic contrast the greater the asymmetry between on- and off-components reflecting non-transient activity. Thus "selective" stimulation of a mechanism is revealed by its relative response amplitude with respect to the activity of another mechanism.

Temporal tuning of the reversal response is a stricter test of selectivity. Low-pass is characteristic of parvo-activity and band-pass tuning reveals transient-type magno-responses. Isoluminant red/green gratings generate low pass VEPs only up to a contrast increment of 0.1 (above this contrast magno-contribution becomes significant and temporal tuning becomes band-pass). Thus reversal presentations of higher contrasts should be checked for selectivity.

These observations are consistent with single-unit recordings in macaque striate cortex: recorded responses are sustained (low-pass) only for cells responding to low chromatic contrast, and transient (band-pass) only for cells sensitive to low achromatic contrast. Cells with higher contrast thresholds are common and have intermediate responses, consistent with recent demonstrations of dual P/M inputs to some chromatic cells (Vidyasagar, Kulikowski and Dreher, *Australian Neuroscience meeting* January 1998).

Posters

First and second order coding of orientation: evidence from the tilt aftereffect

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We used luminance-modulated (LM) and contrast-modulated (CM) gratings to test (a) whether a second-order tilt aftereffect (TAE) exists, and (b) whether LM adaptation can induce an aftereffect on CM gratings and vice versa—a crossover effect. Gratings were 1 c/deg with contrast set at a fixed multiple of individual subject thresholds (8x threshold for adapters, 5x and 8x for test gratings). Adapters were tilted +/-15 deg from vertical; carrier pattern was 2-D static, binary noise with 45% contrast. Initial adaptation was for 3 minutes, topped up for 2 seconds between 150 msec test presentations. The experiment was controlled by an interleaved staircase procedure that measured the TAE by nulling it, hence making a tilted test grating appear vertical. In a single-adaptation condition, subjects adapted and tested to LM or CM gratings. In two double-adaptation conditions, the LM and CM gratings were superimposed at opposite orientations (“plaid”) or at the same orientation (“compound grating”). With CM adaptation and CM test we found a second-order TAE, of similar magnitude to the first-order TAE. A crossover TAE (from LM to CM or CM to LM) was also found. These findings can be interpreted in terms of a 2-stage model of orientation coding (Anderson and Georgeson, 1997 *Perception* **26** (supp.) 122), in which cue-specific filters (LM or CM; stage 1) are later integrated.

The effect of contrast polarity on the shift in perceived edge location in 2D blobs with blurred edges (Unpublished)

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It is generally accepted that in the presence of blur the perceived edge location is not coincident with the zero crossing of the second spatial derivative, but it is shifted towards the area of lower luminance. The magnitude of this shift is a function of blur and contrast, and various models and explanations have been proposed (e.g. Georgeson and Freeman, 1997 *Vision Research* **37** 127-142; Mather and Morgan, 1986 *Vision*

Research **26** 1007-1015). Most experiments were conducted on one-dimensional stimuli. In our work, concerned with modelling of edge localisation in skin lesions (dark on light background), we observed that the edges drawn by clinicians tended towards the *brighter* side, which surprised us. Subsequent controlled experiments confirmed these observations. We used 2D blobs with varying blur and contrast and both polarities. Whereas for the bright blobs the results were consistent with the results of earlier work, for the dark blobs the boundaries were displaced outwards, in the direction of the *lighter* background, but by smaller amounts than in the corresponding blobs of the opposite polarity. We would like to present the results of the experiments with the hope of receiving feedback which would direct our further research towards a computational model which correctly predicts the perceived edge location in blobs present in complex medical 2D images.

Linear time-varying receptive fields explain complex-cell behaviour

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Unlike simple cells, complex cells in mammalian visual cortex appear to be nonlinear mechanisms lacking a structured receptive field (RF), and different complex cells display a variety of mutually inconsistent behaviours. Current complex-cell models postulate nonlinear interactions among multiple simultaneous afferents, but none explains the variety of complex-cell behaviours. We have explored an alternative scheme where these afferents are sequential rather than simultaneous, with a sequence that repeats cyclically over time. A cell receiving afferents this way can be described as if its spatial RF changes shape cyclically over time. Different time-varying RFs arise when the number of afferents, their individual spatial RFs and/or their sequence varies, and we present simulation results showing that they exhibit all reported varieties of complex-cell behaviour. Our results suggest a common linear functional description for simple and complex cells. Nonlinearities are not required to explain complex-cell behaviour.

Spatial probability summation for detecting four patches of grating

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When components of a compound pattern stimulate different visual mechanisms, psychophysical performance typically improves by a small amount consistent with probability summation. In spatial vision, compound stimuli have been made from (a) components with different spatial frequencies or orientations and (b) gratings with variable spatial extent (Graham, 1989 *Visual Pattern Analysers* Oxford). In (a) the number of components in the compound is usually less than four, and in (b) full psychometric functions are rarely, if ever, shown, and interpretation is difficult because sensitivity is not always uniform across the stimulated region. We overcame these previous limitations in the following way. Using a 2AFC technique and the method of constant stimuli, we measured psychometric functions for detecting (i) single 3.75 deg circular patches of 1 c/deg grating centred on each of four corners of an imaginary square surrounding the fixation point and (ii) a compound in which the four grating patches were presented simultaneously. The centres of the patches were 4.24 deg from the fixation point and the sine-phase gratings were windowed by a raised cosine function to remove sharp luminance borders. Stimulus duration was 100 ms. Individual psychometric functions were derived from between 1600 and 2000 trials and the four component-functions were combined probabilistically, producing excellent predictions for the four-patch compound. These results are consistent with probability summation between four independent detectors sensitive to one of each of the four stimulus patches.

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Recognition of faces and facial expressions in central and peripheral vision

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Ten subjects performed a forced-choice identification of stationary 512x512 pixel 12-bit greyscale images of 10 famous faces (5 male and 5 female film stars) presented for 1 sec in central vision and at four eccentricities along the horizontal meridian. The magnification of the peripheral stimuli was increased in accordance with published M-scaling data for contrast sensitivity by varying the viewing distance as follows: 0 deg = 5m; 3 deg = 2.5m; 10 deg = 1m; 20 deg = 0.61m; 40 deg = 0.27m. It was found that recognition decreased strongly with eccentricity despite the scaling. Performance also decreased in progressively degraded images (256x256, 128x128, 64x64 and 32x32 binary images) but there was no significant interaction between eccentricity and resolution: thus the steep decline of performance in the periphery does not depend on the high spatial frequency or low contrast content of the face image. A further 7 subjects performed forced-choice identification of 5 emotional expressions under the same experimental conditions: absolute performance in terms of total errors made was worse in this task, but the slope of the decrease with eccentricity was similar (see also Wright and Bentley, *Perception* **19** 270-271). It is concluded that the recognition of facial identity and facial emotion are limited by visual processes which decrease with eccentricity more steeply than contrast sensitivity.

The role of functional cerebral asymmetry in the perception of faces

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It has been found that male subjects make systematic errors in the identification of female faces placed in the Left Visual Field (LVF) i.e. when mediated by the right hemisphere. This is surprising because males are thought to have a right-hemisphere advantage in the accuracy and speed of face identification (Rizzolatti and Buchtel, 1977 *Cortex* **13** 300-305; Young and Bion, 1983 *Cortex* **19** 215-225). One possibility is that the

right-hemisphere advantage is specialised for own-gender faces. In this study, it was found that, in male subjects, the estimation of profile orientation, gender, and identification of personality type was significantly faster for profiles presented in the LVF than in the RVF and that these effects were stronger when male profiles were used. In females, no significant difference in face identification thresholds for the LVF and RVF was found. In the LVF, mean recognition time for profile orientation, gender, and personality type were much longer for females than for males. In addition, in males, the frequency of personality identification errors in the LVF was less than in the RVF, even with an increase in presentation time. Thus, in males, there is an advantage of the right hemisphere in mediating accurate identification and processing of profiles, particularly male profiles. In contrast, in females, the numbers of errors in the LVF and RVF were about equal. The error distribution curves for both visual fields were similar, and the number of errors changed rather little with an increase in presentation time. Such uniformity of responses to stimuli presented in the LVF and RVF suggests the equal participation of the right and left hemispheres in face identification in females. Analysis of the personality identification errors showed that systematic errors predominated in the LVF, although it is in this visual hemifield that identification is very accurate. The direction of identification errors was found to be different in males and females: females were more often mistaken in the recognition of male faces, and males in the identification of female faces.

A new slant on the tilt aftereffect: orientation aftereffects on global perception of heterogeneous line-segment textures

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After viewing a row of obliquely oriented lines (inducer), observers commonly report that a row of vertically oriented lines appear tilted in the opposite direction to the previously viewed inducer. This is known as the tilt aftereffect (Appelle, 1972 *Psychological Bulletin* **78** 266-278) and is thought to reflect adaptation or fatigue processes of orientation selective visual neurons. We have previously shown that orientation sensitivity can be quantified using a texture coherence paradigm similar to that used to study sensitivity to global motion in random dot kinematograms. Using heterogeneously oriented line segment textures, we obtained global orientation thresholds by determining the minimum percentage of

coherently oriented line segments (amidst randomly oriented “noise” lines) required for just correct global orientation judgments. We asked whether pre-exposure to 100% coherently oriented textures would cause alterations to orientation sensitivity consistent with the tilt aftereffect. Since analogous effects in motion can be produced with very brief exposure to inducers (Raymond & Isaak, 1998 *Vision Research* **38** 579-589), we asked whether global orientation aftereffects could also be produced with brief inducers. We presented observers with a 200 msec texture patch (inducer) composed of short line segments oriented horizontally or vertically. After 200 msec, a similar but partially-coherent texture (test) was presented for 180 msec. The percentage of coherently oriented segments in the test patch was varied from trial to trial and observers reported the global orientation of both inducer and test textures. Mean orientation coherence thresholds were significantly elevated when test orientations matched that of the inducer and were reduced when test and inducer were orthogonal. These data demonstrate that viewing briefly presented, homogeneously oriented textures dramatically changes subsequent global orientation sensitivity to similar, partially coherent textures depending on the orientation relationship between them.

Blur discrimination in the chromatic and luminance domain

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When a red-green sinusoidal grating is presented to observers with normal colour vision, observers usually report that the sinusoidal grating looks more like a square wave than a sine wave. In contrast, a sinusoidal luminance grating of the same spatial frequency is perceived veridically as a sine wave. This phenomenon was first noted by Helmholtz (1909), and has been reported by others (e.g. Mullen, 1982 *Journal of Physiology* **332** 14P), but to our knowledge it has so far not been studied systematically.

We investigated a phenomenon related to chromatic sharpening, namely blur discriminability, in the various colour directions. We measured blur thresholds for square-wave gratings modulated either along the red-green, luminance, or yellow-blue colour directions. We used a 2IFC procedure to assess the amount of blur tolerated. One interval contained the square-wave stimulus and the other contained a blurred square-wave stimulus. We asked the subjects to identify the interval

which contained the square-wave stimulus. Stimulus blur was varied by convolving the square-wave grating with a Gaussian mask of varying standard deviations. Blur thresholds were defined as 80% correct response. Blur thresholds for red-green and luminance stimuli were very similar (approx. 1 minute of visual angle). These results are consistent with the idea that the luminance and red-green channels have similar spatial properties. The blur thresholds for yellow-blue were much higher (between 2 and 8 minutes of visual angle) than for the other two directions. A more robust understanding of human spatiochromatic image processing may lead to more efficient image compression techniques.

No use for rose-coloured glasses: A study on the effect of colour on transient system activity with implications for dyslexia research

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Results from recent psychophysical studies have been interpreted to suggest that activity in transient/magnocellular pathways is enhanced by short-wavelength blue light (e.g. Williams et al, 1991 *Vision Research* **31** 2017-2023). Based on the premise that many dyslexic children suffer from a transient system deficit, such results have formed a theoretical basis for remedial work into dyslexia utilising coloured overlays, lenses and text. The current study used normal readers and was designed to explore the proposal that transient system activity is increased by short-wavelength light and attenuated with longer wavelength light. The study adopted metacontrast designs using coloured masks in light and dark ambient conditions, a Turnus apparent motion task on coloured backgrounds, and two measures of visual latency: temporal order judgement and reaction time, using coloured targets. The results demonstrated that colour had little or no differential effect on either the magnitude or speed of transient system activity, other than a decrease in some instances with red light as predicted by physiological research. However, the predicted pattern of results was demonstrated when contrast rather than colour was manipulated in a final metacontrast study. The results suggest, that conclusions regarding the differential effects of wavelength on transient system activity may be premature, possibly reflecting a colour/contrast confound. However, as the current studies

were conducted on normal readers, one can not eliminate the possibility that dyslexic readers *per se* may receive a beneficial effect of colour on reading, either as a result of some sort of visual anomaly in colour processing and/or in reducing visual discomfort.

Depth perception from disparity of contrast envelopes: sorting the facts from the artefacts

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In previous work we showed that stereo depth perception for Gabor patches can exploit the disparity of the carrier (first order disparity) and the disparity of the envelope (second order) (AVA Dundee, April 1997). We also modelled the interaction and combination of these two cues (AVA Guildford, September 1997). We consider here the possibility that second-order stereo depends upon vergence movements, or is an artefact of distortion products that introduce first order information about the contrast envelope. Reducing the presentation time from 300 to 150 ms had little or no effect on depth estimates for horizontal Gabor patches, suggesting that vergence is not important. Depth estimates obtained at peak contrasts of 32%, 8% and 4% were all very similar. This rules out the compressive distortion hypothesis, because such distortion decreases as the square of contrast and so would be negligible at low contrasts.

We then investigated what cues in the contrast envelope were being used for depth perception, by presenting horizontal Gabors and filtered noise patches with correlations of +1 and -1 between the eyes. Depth perception was possible, though much more variable, for the negatively correlated patches that contained no matchable first order features. With -1 correlation there was a bias to respond "back" more often, equivalent to approx 1/4 cycle shift of disparity for the Gabors and 1/2 cycle for the filtered noise. When envelope cues are weak, unmatched features may act as half-occlusion cues (Shimojo & Nakayama, 1994 *Vision Research* **34** 1875-1881; Anderson, 1994 *Nature* **367** 365-368) that drive the percept back so that the response is consistent with a surface seen behind an aperture.

Representational momentum and the human face.

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Faces are complex objects. One dimension of this complexity that is often ignored, at least in respect to processing facial identity, is the fact that faces move. That is, when we smile, speak or gesture approval, our faces change shape. How do such non-rigid transformations influence the way we perceive and represent specific faces? Does motion simply add noise, or could a transforming face actually enhance processing in some way?

Thornton and Kourtzi (1997 *IOVS* **38 (Supp.)** 1004) recently reported performance advantages in a sequential identity matching task when the first image of a face was a short video clip versus a single still frame. The current work explores whether such advantages might arise due to the creation of what Freyd (1987 *Psychological Review* **94** 427-438) has termed dynamic mental representations. Evidence for these structures has come mainly from representational momentum studies in which the final position or configuration of a transforming object is misremembered as being further forward in the direction of motion or change.

Can we find evidence for similar memory distortions when video clips of facial expressions are used? That is, when shown a dynamic smiling or frowning face, will participants misremember the stopping point as being more intense than the true stopping point? Results indicate no evidence for such forward memory bias. Rather, a consistent bias back towards the starting point of the video sequence was observed, suggesting that face-specific dynamic constraints may be overriding more general representational factors (e.g. motion anticipation) during performance of this task.

Temporal processing of spatial alignment information across gaps

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The effects of exposure duration on alignment thresholds for separated lines were investigated in this study. Alignment thresholds for equally visible lines (i.e. lines a constant multiple above contrast detection threshold) separated by 1.5 deg, were measured for different exposure

durations (15-1000 msec). This condition was interleaved with those where the stimulus was closely followed by spatial noise masks. Alignment thresholds for equally visible stimuli presented without a postmask improved with increasing exposure duration as a power function with an exponent of approximately -0.1. However, when the stimulus was closely followed by an appropriate spatial mask, thresholds improved as a power function with an exponent close to -0.5. Experiments did not show a significant change in the spatial scale characteristics of the most effective mask across exposure duration. The improvement in alignment thresholds over time is most likely a result of a square-root temporal integration process occurring for alignment calculations made between separated targets.

Contrast- and luminance-modulated masking as a function of spatial frequency and phase.

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Previous studies have shown that a low-spatial-frequency contrast-modulated grating (beat), composed of two high spatial frequency sinusoids, severely masks the detection of a sinusoid at the beat frequency (Henning, Hertz & Broadbent, 1975 *Vision Research* **15** 887-899). This finding could suggest that channels tuned for low and high spatial frequencies are not completely independent. Alternatively, the masking could arise as a result of an early nonlinearity injecting a distortion product at the beat frequency. If so, the effects of masking by a beat should be similar to those of masking by a 'real' grating at the same frequency. Here, we explore the effects of masking by a beat and a 'real' grating on the detection of test gratings as a function of both spatial frequency and phase.

Contrast thresholds were measured for a range of test spatial frequencies (0.25 - 4.0 c/deg) in the presence of a masking grating. The mask was either (a) a contrast modulated grating with a beat frequency of 1 c/deg and components of 8 and 9 c/deg, each with a contrast of 20% or (b) an 8 c/deg sinusoidal grating of 20% contrast plus a 1 c/deg grating of 3% contrast. The phase of the test grating was randomised at the start of each trial.

Under some conditions the effects of masking by beats and 'real'

gratings were similar. Specifically, both the beat and the 'real' grating produced robust elevations of contrast threshold about the beat frequency (see also Smallman and Harris, 1995 *Perception* **24** 127). However, not all the data lend support to the simple distortion product hypothesis: the detection of test gratings in the presence of a real masking grating is dependent on phase, but detection is phase-independent when masked by a beat of the same frequency.

Motion in depth and nonrigid motion of subjective contours.

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Using computer animation techniques it is demonstrated that a Kanisza square can be made to rotate in depth or advance and recede. The square is seen as a surface moving in front of the background dots. The subjective contours of a Kanisza square rotating in depth can appear slanted or tilted in depth even without stereoscopic cues. The effect depends upon using perspective projection. If perspective cues are removed from the rotating square, the percept becomes ambiguous, and it can be seen either as a square rotating in depth or as a flat rectangle undergoing nonrigid motion (squashing and stretching). Replacing either the inducing dots or the background with an equiluminous random texture almost completely abolishes the subjective contours when stationary but they reappear when the square is in motion.

However, a rotating Kanisza square composed entirely of second-order motion contours (accretion and deletion of texture) does not show contour completion over a textured background. It is concluded that motion and perspective can give rise to subjective surfaces slanted or tilted in depth, and to non-rigid as well as rigid surfaces. The effects are as strong or stronger than with stationary figures.

Mapping colour- and brightness contrast over the visual field

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If brightness contrast is set to be equal for two coloured stimuli A and B

presented in the fovea, would it remain equal when these stimuli are presented in other regions of the visual field? Results of this study with an original method of equalizing brightness contrast suggest that the answer is probably 'No'.

Our method is based on recording of reaction time (RT) to coloured stimuli of various luminances presented against a constant coloured background. If stimulus and background colours are the same, than a stimulus with a brightness value equal to a brightness value of the background is invisible and undetected (RT is infinity). But if the colours of the stimulus and the background are different, the equalization of the brightness contrast leads only to partial impairment of detection (RT is maximum but not infinity).

Thus, the maximum RT can be used as an indication of the minimum brightness contrast. In experiments applying this criterion to stimuli presented in various areas of a computer display we have obtained 'maps' of retinal sensitivity to different combinations of colour and brightness contrast. The analysis of these 'maps' demonstrates that the luminance value at which the RT reaches its maximum differs significantly between the fovea and parafoveal and peripheral regions.

The direction and size of the discrepancy depend on stimulus and background colours, stimulus size and background luminance. Results of a clinical study with 28 normal subjects and 320 patients (hereditary and acquired colour defects, amblyopia, albinism, glaucoma and Stargardt's dystrophy) have shown that these 'maps' exhibit characteristic patterns for different eye diseases.

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Gale, A.S., Brown, I.D., Haslegrave, C.M., Krusysse, 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).

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Selected References



Adini, Y, Sagi, D and Tsodyks, M (1997) Excitatory-inhibitory network in the visual cortex: psychophysical evidence. *Proceedings of the National Academy of Sciences of the United States of America* 94, 10426-10431

Anderson, BL (1997) A theory of illusory lightness and transparency in monocular and binocular images: the role of contour junctions. *Perception* 26, 419-453

Applegate, AR and Howland, HC (1997) Refractive surgery, optical aberrations, and visual performance (vol 13, pg 295, 1997). *Journal of Refractive Surgery* 13, 490-490

Baloch, AA and Grossberg, S (1997) A neural model of high-level motion processing: line motion and formotion dynamics. *Vision Research* 37, 3037-3059

Barrett, BT, Cox, MJ, Simmers, AJ and Gray, LS (1997) Grating detection and orientation discrimination in amblyopia. *Current Eye Research* 16, 1044-1049

Begemann, SHA, Vandenbeld, GJ and Tenner, AD (1997) Daylight, artificial light and people in an office environment, overview of visual and biological responses. *International Journal of Industrial Ergonomics* 20, 231-239

Behrmann, M, Watt, S, Black, SE and Barton, JJS (1997) Impaired visual search in patients with unilateral neglect: an oculographic analysis. *Neuropsychologia* 35, 1445-1458

Bennamoun, M and Boashash, B (1997) A structural-description-based vision system for automatic object recognition. *IEEE Transactions on Systems Man and Cybernetics Part B-Cybernetics* 27, 893-906

Bifone, A, Degroot, HJM and Buda, F (1997) Ab initio molecular dynamics of rhodopsin. *Pure and Applied Chemistry* 69, 2105-2110

Blakeslee, B and Mccourt, ME (1997) Similar mechanisms underlie simultaneous brightness contrast and grating induction. *Vision Research* 37, 2849-2869

Bloch, H (1997) The role of vision in the development of goal-directed movements. *Perception* 26, 771-771

Bondarko, VM, Nevskaya, AA and Leushina, LI (1997) Development of children's notion about the visual world in early infancy. *Perception* 26, 790-791

Born, P, Rostrup, E, Larsson, HBW, Leth, H, Miranda, M, Peitersen, B and Lou, HC (1997) Infant visual cortex function evaluated by fMRI. *Perception* 26, 758-759

Brady, LW, Freire, JE, Longton, WA, Miyamoto, CT, Augsburger, JJ, Brown, gc, Micaily, B and Sagerman, RH (1997) Radiation therapy for macular degeneration: technical considerations and preliminary results. *International Journal of Radiation Oncology Biology Physics* 39, 945-948

Brenner, E, Vandamme, WJM and Smeets, JBJ (1997) Holding an object one is looking at: kinesthetic information on the object's distance does not improve visual judgments of its size. *Perception & Psychophysics* 59, 1153-1159

Brettel, H, Vienot, F and Mollon, JD (1997) Computerized simulation of color appearance for dichromats. *Journal of the Optical Society of America A-Optics Image Science and Vision* 14, 2647-2655

Cabello, J and Stiles, WS (1997) Sensitivity of rods and cones in the parafovea (reprinted from *Anales de la Real Sociedad Espanol de Fisica y Quimica, Serie A*, vol 46, pg 251-282, 1950). *Color research and Application* 22, 338-354

Carandini, M, Heeger, DJ and Movshon, JA (1997) Linearity and normalization in simple cells of the macaque primary visual cortex. *Journal of Neuroscience* 17, 8621-8644

Carevic, D and Caelli, T (1997) Application of partial modeling techniques for texture segmentation. *Journal of the Optical Society of America A-Optics Image Science and Vision* 14, 2924-2937

- Carkeet, A, Levi, DM and Manny, RE (1997) Development of vernier acuity in childhood. *Optometry and Vision Science* 74, 741-750
- Chey, J, Grossberg, S and Mingolla, E (1997) Neural dynamics of motion grouping: from aperture ambiguity to object speed and direction. *Journal of the Optical Society of America A-Optics Image Science and Vision* 14, 2570-2594
- Crane, BT and Demer, JL (1997) Human gaze stabilization during natural activities: translation, rotation, magnification, and target distance effects. *Journal of Neurophysiology* 78, 2129-2144
- Crawford, JD and Guitton, D (1997) Visual-motor transformations required for accurate and kinematically correct saccades. *Journal of Neurophysiology* 78, 1447-1467
- Crognale, MA, Kelly, JP, Chang, S, Weiss, AH and Teller, DY (1997) Development of pattern visual evoked potentials: longitudinal measurements in human infants. *Optometry and Vision Science* 74, 808-815
- Crognale, MA, Switkes, E and Adams, AJ (1997) Temporal response characteristics of the spatiochromatic visual evoked potential: nonlinearities and departures from psychophysics. *Journal of the Optical Society of America A-Optics Image Science and Vision* 14, 2595-2607
- Dakin, SC and Watt, RJ (1997) The computation of orientation statistics from visual texture. *Vision Research* 37, 3181-3192
- Darling, WG and Hondzinski, JM (1997) Visual perceptions of vertical and intrinsic longitudinal axes. *Experimental Brain Research* 116, 485-492
- Devries, SH and Baylor, DA (1997) Mosaic arrangement of ganglion cell receptive fields in rabbit retina. *Journal of Neurophysiology* 78, 2048-2060
- Dorai, C and Jain, AK (1997) Shape spectrum based view grouping and matching of 3D free-form objects. *IEEE Transactions on Pattern Analysis and Machine Intelligence* 19, 1139-1146

Ehrlich, DL, Braddick, OJ, Atkinson, J, Anker, S, Weeks, F and Hartley, T (1997) Infant emmetropization: longitudinal changes in refraction components from nine to twenty months of age. *Optometry and Vision Science* 74, 822-843

Elliott, DB, Trukoloilic, M, Strong, JG, Pace, R, Plotkin, A and Bevers, P (1997) Demographic characteristics of the vision-disabled elderly. *Investigative Ophthalmology & Visual Science* 38, 2566-2575

Epelboim, J, Booth, JR, Ashkenazy, R, Taleghani, A and Steinman, RM (1997) Fillers and spaces in text: the importance of word recognition during reading. *Vision Research* 37, 2899-2914

Farcy, R and Damaschini, R (1997) Triangulating laser profilometer as a three-dimensional space perception system for the blind. *Applied Optics* 36, 8227-8232

Ferrera, VP and Lisberger, SG (1997) Neuronal responses in visual areas MT and MST during smooth pursuit target selection. *Journal of Neurophysiology* 78, 1433-1446

Field, DJ and Brady, N (1997) Visual sensitivity, blur and the sources of variability in the amplitude spectra of natural scenes. *Vision Research* 37, 3367-3383

Fink, GR, Halligan, PW, Marshall, JC, Frith, CD, Frackowiak, RSJ and Dolan, RJ (1997) Neural mechanisms involved in the processing of global and local aspects of hierarchically organized visual stimuli. *Brain* 120, 1779-1791

Fredericksen, RE and Hess, RF (1997) Temporal detection in human vision: dependence on stimulus energy. *Journal of the Optical Society of America A-Optics Image Science and Vision* 14, 2557-2569

Frisby, JP, Catherall, C, Porrill, J and Buckley, D (1997) Sequential stereopsis using high-pass spatial frequency filtered textures. *Vision Research* 37, 3109-3116

Geller, AM and Hudnell, HK (1997) Critical issues in the use and analysis of the lanthony desaturate color vision test. *Neurotoxicology and*

Teratology 19, 455-465

Georgeson, MA and Meese, TS (1997) Perception of stationary plaids: the role of spatial filters in edge analysis. *Vision Research* 37, 3255-3271

Gottlob, I and Weinacht, S (1997) Pre-term and full-term infants: visual development. *Perception* 26, 761-762

Gwiazda, J, Bauer, J, Thorn, F and Held, R (1997) Development of spatial contrast sensitivity from infancy to adulthood: psychophysical data. *Optometry and Vision Science* 74, 785-789

Hainline, L and Abramov, I (1997) Eye movement-based measures of development of spatial contrast sensitivity in infants. *Optometry and Vision Science* 74, 790-799

Hamada, T, Yamashima, M and Kato, K (1997) A ring model for spatiotemporal properties of simple cells in the visual cortex. *Biological Cybernetics* 77, 225-233

Harvey, EM, Dobson, V and Narter, DB (1997) The influence of a central stimulus on visual field measurements in children from 3.5 to 30 months of age. *Optometry and Vision Science* 74, 768-774

Hess, RF, McIlhagga, W and Field, DJ (1997) Contour integration in strabismic amblyopia: the sufficiency of an explanation based on positional uncertainty. *Vision Research* 37, 3145-3161

Hyvarinen, L and Hirvonen, U (1997) Assessment of impaired vision during the first year. *Perception* 26, 790-790

Jezzard, P, Rauschecker, JP and Malonek, D (1997) An in vivo model for functional MRI in cat visual cortex. *Magnetic Resonance in Medicine* 38, 699-705

Joly, TJ and Bender, DB (1997) Loss of relative-motion sensitivity in the monkey superior colliculus after lesions of cortical area MT. *Experimental Brain Research* 117, 43-58

Kaneko, H and Howard, IP (1997) Spatial limitation of vertical-size disparity processing. *Vision Research* 37, 2871-2878

Keeble, DRT, Kingdom, FAA and Morgan, MJ (1997) The orientational resolution of human texture perception. *Vision Research* 37, 2993-3007

Khang, BG and Essock, EA (1997) A motion illusion from two-dimensional periodic patterns. *Perception* 26, 585-597

Lappin, JS and Craft, WD (1997) Definition and detection of binocular disparity. *Vision Research* 37, 2953-2974

Lazzari, S, Vercher, JL and Buizza, A (1997) Manuo-ocular coordination in target tracking .1. a model simulating human performance. *Biological Cybernetics* 77, 257-266

Lee, DY, Cotter, SA and French, AL (1997) Evaluation of Kojima-Matsubara color vision test plates: validity in young children. *Optometry and Vision Science* 74, 726-731

Lengyel, D, Weinacht, S, Charlier, J and Gottlob, I (1997) Visual pursuit in infants. *Perception* 26, 757-757

Levi, DM, Sharma, V and Klein, SA (1997) Feature integration in pattern perception. *Proceedings of the National Academy of Sciences of the United States of America* 94, 11742-11746

Liang, JZ, Williams, DR and Miller, DT (1997) Supernormal vision and high-resolution retinal imaging through adaptive optics. *Journal of the Optical Society of America A-Optics Image Science and Vision* 14, 2884-2892

Liinasuo, M, Rovamo, J and Kojo, I (1997) Effects of spatial configuration and number of fixations on kanizsa triangle detection. *Investigative Ophthalmology & Visual Science* 38, 2554-2565

Lindblom, B, Westheimer, G and Hoyt, WF (1997) Torsional diplopia and its perceptual consequences - a 'user- friendly' test for oblique eye muscle palsies. *Neuro-Ophthalmology* 18, 105-110

Lueder, GT and Garibaldi, D (1997) Comparison of visual acuity measured with allen figures and snellen letters using the B-VAT II monitor. *Ophthalmology* 104, 1758-1761

- Mapelli, D and Behrmann, M (1997) The role of color in object recognition: evidence from visual agnosia. *Neurocase* 3, 237-247
- Marcar, VL, Zihl, J and Cowey, A (1997) Comparing the visual deficits of a motion blind patient with the visual deficits of monkeys with area MT removed. *Neuropsychologia* 35, 1459-1465
- Marraffa, M, Mansoldo, C, Morbio, R, Denatale, R, Tomazzoli, L and Bonomi, L (1997) Does nerve fiber layer thickness correlate with visual field defects in glaucoma? a study with the nerve fiber analyzer. *Ophthalmologica* 211, 338-340
- Martinezbaena, J, Fdezvaldivia, J and Garcia, JA (1997) A multi-channel autofocusing scheme for gray-level shape scale detection. *Pattern Recognition* 30, 1769-1786
- McCarthy, G, Puce, A, Gore, JC and Allison, T (1997) Face-specific processing in the human fusiform gyrus. *Journal of Cognitive Neuroscience* 9, 605-610
- Michalikova, L, Nagy, LT and Mocko, V (1997) The evaluation of the visual field by the method of digital topology. *Annals of Ophthalmology-Glaucoma* 29, 302-305
- Morrone, MC, Ross, J and Burr, DC (1997) Apparent position of visual targets during real and simulated saccadic eye movements. *Journal of Neuroscience* 17, 7941-7953
- Moscovitch, M, Winocur, G and Behrmann, M (1997) What is special about face recognition? Nineteen experiments on a person with visual object agnosia and dyslexia but normal face recognition. *Journal of Cognitive Neuroscience* 9, 555-604
- Moseley, MJ, Fielder, AR, Irwin, M, Jones, HS and Auld, RJ (1997) Effectiveness of occlusion therapy in ametropic amblyopia: a pilot study. *British Journal of Ophthalmology* 81, 956-961
- Moutoussis, K and Zeki, S (1997) Functional segregation and temporal hierarchy of the visual perceptive systems. *Proceedings of the Royal Society of London Series B-Biological Sciences* 264, 1407-1414

Nascimento, SMC, Foster, DH and McKee, P (1997) Binary masks yielding gaussian light distributions in Maxwellian view. *Vision Research* 37, 2975-2979

Niemann, T and Hoffmann, KP (1997) Motion processing for saccadic eye movements during the visually induced sensation of ego-motion in humans. *Vision Research* 37, 3163-3170

Osorio, D, Marshall, NJ and Cronin, TW (1997) Stomatopod photoreceptor spectral tuning as an adaptation for colour constancy in water. *Vision Research* 37, 3299-3309

Parrish, RK, Gedde, SJ, Scott, IU, Feuer, WJ, Schiffman, JC and Mangione, CM (1997) Visual function and quality of life among patients with glaucoma. *Archives of Ophthalmology* 115, 1447-1455

Passaglia, C, Dodge, F, Herzog, E, Jackson, S and Barlow, R (1997) Deciphering a neural code for vision. *Proceedings of the National Academy of Sciences of the United States of America* 94, 12649-12654

Pelah, A (1997) The vision of natural and complex images. *Vision Research* 37, 3201-3202

Peli, E (1997) In search of a contrast metric: matching the perceived contrast of gabor patches at different phases and bandwidths. *Vision Research* 37, 3217-3224

Pointer, MR and Attridge, GG (1997) Some aspects of the visual scaling of large colour differences. *Color Research and Application* 22, 298-307

Poole, CJM, Hill, DJ, Christie, JL and Birch, J (1997) Deficient colour vision and interpretation of histopathology slides: cross sectional study. *British Medical Journal* 315, 1279-1281

Rainville, SJM and Kingdom, FAA (1997) The mechanisms for detecting compressively sampled gratings. *Vision Research* 37, 3237-3254

Richards, JE and Hunter, SK (1997) Peripheral stimulus localization by infants with eye and head movements during visual attention. *Vision Research* 37, 3021-3035

- Rohaly, AM, Ahumada, AJ and Watson, AB (1997) Object detection in natural backgrounds predicted by discrimination performance and models. *Vision Research* 37, 3225-3235
- Roorda, A, Campbell, MCW and Bobier, WR (1997) Slope-based eccentric photorefraction: theoretical analysis of different light source configurations and effects of ocular aberrations. *Journal of the Optical Society of America A-Optics Image Science and Vision* 14, 2547-2556
- Schrauf, M and Wist, ER (1997) Visual performance based on motion contrast: a new technique for assessing the development of dynamic vision. *Perception* 26, 778-778
- Shepherd, AJ (1997) Calibrating screens for continuous colour displays. *Spatial Vision* 11, 57-74
- Simmers, AJ, Gray, LS and Spowart, K (1997) A comparison of logarithmic and Snellen-based visual acuity charts in a paediatric population. *Perception* 26, 776-776
- Slater, D and Healey, G (1997) The illumination-invariant matching of deterministic local structure in color images. *IEEE Transactions on Pattern Analysis and Machine Intelligence* 19, 1146-1151
- Snowden, RJ and Milne, AB (1997) Phantom motion aftereffects - evidence of detectors for the analysis of optic flow. *Current Biology* 7, 717-722
- Stolz, JA and Besner, D (1997) Visual word recognition: effort after meaning but not (necessarily) meaning after effort. *Journal of Experimental Psychology-Human Perception and Performance* 23, 1314-1322
- Strasburger, H (1997) Use of computers and cathode-ray-tube displays in visual psychophysics .2.. *Spatial Vision* 11, 1-2
- Suttle, CM, Anderson, SJ and Harding, GFA (1997) A longitudinal study of visual evoked responses to tritan stimuli in human infants. *Optometry and Vision Science* 74, 717-725
- Tardif, E, Richer, L, Bergeron, A, Lepore, F and Guillemot, JP (1997)

Spatial resolution and contrast sensitivity of single neurons in area 19 of split-chiasm cats: a comparison with primary visual cortex. *European Journal of Neuroscience* 9, 1929-1939

Teesalu, P, Vihanninjoki, K, Airaksinen, PJ, Tuulonen, A and Laara, E (1997) Correlation of blue-on-yellow visual fields with scanning confocal laser optic disc measurements. *Investigative Ophthalmology & Visual Science* 38, 2452-2459

Teller, DY (1997) First glances: the vision of infants - the Friedenwald lecture. *Investigative Ophthalmology & Visual Science* 38, 2183-2203

Tipper, SP, Rafal, R, Reuterlorenz, PA, Starrveldt, Y, Ro, T and Egly, R (1997) Object-based facilitation and inhibition from visual orienting in the human split-brain. *Journal of Experimental Psychology-Human Perception and Performance* 23, 1522-1532

Tolhurst, DJ and Tadmor, Y (1997) Band-limited contrast in natural images explains the detectability of changes in the amplitude spectra. *Vision Research* 37, 3203-3215

Tootell, RBH, Mendola, JD, Hadjikhani, NK, Ledden, PJ, Liu, AK and Reppas, JB (1997) Functional analysis of V3A and related areas in human visual cortex. *Journal of Neuroscience* 17, 7060-7078

Tychsen, L and Burkhalter, A (1997) Nasotemporal asymmetries in V1: ocular dominance columns of infant, adult, and strabismic macaque monkeys. *Journal of Comparative Neurology* 388, 32-46

Vecera, SP and Farah, MJ (1997) Is visual image segmentation a bottom-up or an interactive process? *Perception & Psychophysics* 59, 1280-1296

Vimal, RLP (1997) Orientation tuning of the spatial-frequency-tuned mechanisms of the red-green channel. *Journal of the Optical Society of America A-Optics Image Science and Vision* 14, 2622-2632

Viswanathan, AC, Hitchings, RA and Fitzke, FW (1997) How often do patients need visual field tests? *Graefes Archive for Clinical and Experimental Ophthalmology* 235, 563-568

Wang, YZ, Thibos, LN and Bradley, A (1997) Effects of refractive error

on detection acuity and resolution acuity in peripheral vision. *Investigative Ophthalmology & Visual Science* 38, 2134-2143

Wattambell, J and Andrew, R (1997) Directional biases of monocular visual motion processing in young infants. *Perception* 26, 756-756

Webster, MA and Mollon, JD (1997) Adaptation and the color statistics of natural images. *Vision Research* 37, 3283-3298

Wiebe, KJ and Basu, A (1997) Modelling ecologically specialized biological visual systems. *Pattern Recognition* 30, 1687-1703

Wood, JM and Abernethy, B (1997) An assessment of the efficacy of sports vision training programs. *Optometry and Vision Science* 74, 646-659

Yamamoto, K, Kobayashi, Y, Takemura, A, Kawano, K and Kawato, M (1997) A mathematical model that reproduces vertical ocular following responses from visual stimuli by reproducing the simple spike firing frequency of purkinje cells in the cerebellum. *Neuroscience Research* 29, 161-169

Yoshiyama, KK and Johnson, CA (1997) Which method of flicker perimetry is most effective for detection of glaucomatous visual field loss? *Investigative Ophthalmology & Visual Science* 38, 2270-2277

Zeki, S (1997) The autonomy of the visual areas of the human brain and the modularity of consciousness. *Perception* 26, 755-755

Zeki, S and Moutoussis, K (1997) Temporal hierarchy of the visual perceptive systems in the mondrian world. *Proceedings of the Royal Society of London Series B-Biological Sciences* 264, 1415-1419

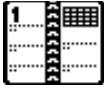
Zemon, V, Hartmann, EE, Gordon, J and Pruntesglowazki, A (1997) An electrophysiological technique for assessment of the development of spatial vision. *Optometry and Vision Science* 74, 708-716

Zhang, ZY (1997) Motion and structure from two perspective views: from essential parameters to euclidean motion through the fundamental matrix. *Journal of the Optical Society of America A-Optics Image Science and Vision* 14, 2938-2950

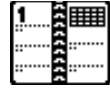
(1997) Vision, learning, and dyslexia - a joint organizational policy statement - American Academy of Optometry - American Optometric Association. *Optometry and Vision Science* 74, 868-870

References supplied (as usual!) by:

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Meetings Calendar



1998

- January 7 Colour Group Vision Meeting
Institute of Ophthalmology
<http://www.city.ac.uk/colourgroup/>
- February 11 AVA Postgraduate meeting
College of Optometrists, London
Contact: Ian Moorhead
I_Moorhead@dera.gov.uk
- May 10-15 ARVO, Ft Lauderdale, USA
<http://www.faseb.org/arvo/>
- August 24-28 ECVP98, Oxford
Abstract deadline: 14 March 1998
Contact: Brian Rogers bjr@psy.ox.ac.uk
<http://www.psych.ox.ac.uk/ecvp98.htm>
- October 23-26 Silmo 1998
<http://www.silmo.fr>

1999

- August 10-14 23rd Pupil Colloquium, Nottingham
<http://www.mailbase.ac.uk/lists/pupil/files/>
- May 9-14 ARVO, Ft Lauderdale, USA
<http://www.faseb.org/arvo/>