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Abstracts for oral presentations (in session order):

Session 1

Edge enhancement in disruptive camouflage

Innes C. Cuthill^{1,2}, Tom S. Troscianko², Anna Kibblewhite^{1,2}, Olivia King^{1,2} & Martin Stevens³
(¹School of Biological Sciences, University of Bristol, Woodland Road, Bristol, BS8 1UG, UK; ²Department of Experimental Psychology, University of Bristol, 12a Priory Road, Bristol, BS8 1TU; ³Department of Zoology, University of Cambridge, Downing Street, Cambridge CB2 3EJ, UK. Email: I.Cuthill@bristol.ac.uk)

Disruptive camouflage is widely used in animal and military camouflage. It is logically distinguished from simple matching of the general background ('crypsis') or specific background objects ('masquerade'), because its effectiveness lies in the disruption of object recognition, as opposed to detection through conspicuousness (Cuthill, et al, 2005, Nature 434, 72-74). For example, high contrast colours placed at the body's edge help break up its outline. The observation that the colour patches of some camouflaged animals exhibit enhanced boundaries, is consistent with the hypothesis that these patterns exploit edge detectors in the predator's visual system (Osorio & Srinivasan, 1991, Proc R Soc B, 244, 81-85; Stevens & Cuthill, 2006, Proc R Soc B, 273, 2141-2147), so enhancing false bounding contours within the body. However, whether this affects detection in nature has never been tested. Using artificial moth-like stimuli with two-tone colours designed to match natural backgrounds as perceived by birds, we show that enhanced colour boundaries significantly reduce detection by wild birds in the field, compared to unenhanced (step-function) or smoothed boundaries. Furthermore, treatments with the same spatial frequency distributions, but phase-randomised, do not have this protective effect. This is consistent with accounts of early vision where spatial coincidence of rapid changes in intensity at different spatial frequencies are used to detect edges. By enhancing the intensity changes at a colour boundary, false edges are detected within the body, so reducing successful detection of the animal's true outline.

Contour integration and crowding: a similar type of mechanism?

Keith A. May¹ & Robert F. Hess² (¹Division of Optometry, University of Bradford, Bradford, BD7 1DP, UK; ²McGill Vision Research, Department of Ophthalmology, 687 Pine Avenue West, Montreal, Quebec, H3A 1A1, Canada. Email: keith@keithmay.org, robert.hess@mcgill.ca)

We studied integration of contours consisting of Gabor elements positioned along a smooth path, embedded amongst distractors. Contour elements were aligned with the path ("snakes") or orthogonal to it ("ladders"). Straight snakes and ladders were easily detected in the fovea but, at an eccentricity of 6°, only snakes were detectable. We propose that the failure to detect peripheral ladders is an example of crowding, the phenomenon observed when identification of peripherally-located letters is disrupted by flanking letters. Pelli, Palomares & Majaj (2004 Journal of Vision 4 1136-1169) outlined a model in which simple feature detectors are followed by integration fields, which mediate tasks requiring the outputs of several detectors (e.g. letter identification). They proposed that crowding occurs because integration fields are larger in the periphery, causing inappropriate feature integration. We

argue that the “association field”, which has been proposed to mediate contour integration (Field, Hayes & Hess, 1993 *Vision Research* 33 173-193), is a type of integration field. Our data are explained by a model in which weak ladder integration competes with strong snake integration. In the fovea, small association fields allow both types of contour to be integrated with little interference. In the periphery, association fields are larger, and a ladder element is likely to be closely aligned with a distractor within the field; the ladder element will then form a snake with the distractor element, disrupting the ladder integration. In contrast, even with large fields, snake elements are usually most strongly linked to their neighbours along the contour.

A straightforward account of texture perception across the visual field

C. Vakrou, D.R.T. Keeble, D. Whitaker & B. Barrett (Vision Science Research Group, Division of Optometry, University of Bradford, Bradford, BD7 1DP, UK. Email: c.vakrou3@Bradford.ac.uk)

The spatial processing of most visual tasks is homogenous across the visual field apart from a change in scale. We investigate the eccentricity-dependent variation in scale for a texture segmentation task in an attempt to account for the many reported observations of central performance drop (e.g. Kehrner, 1987, *Spatial Vision*, 2, 248-261). We measured performance (% correct) for the detection in a 2IFC task of a small patch of oblique lines within a larger background of lines tilted obliquely in the opposite direction. Several different exposure durations were investigated. Stimuli at all eccentricities were simply magnified versions of each other - a method of spatial scaling (Watson, 1987 *JOSA A*, 4, 1579-1582). We obtained estimates of the magnification required to equate performance in central and peripheral vision, quantified by the parameter E2 - the eccentricity at which stimulus size must double to maintain foveal performance. Performance across all eccentricities could be accounted for simply by a change of scale and each exposure duration revealed a unique, critical stimulus size. In other words, there is no qualitative difference in texture perception across the visual field, and there was certainly no evidence for inferior performance at the fovea compared to more peripheral locations (e.g. Yeshurun & Carasco, 1998, *Nature*, 396, 72-75).

Decoding of global forms in the human visual cortex

Dirk Ostwald¹, Judith Lam^{1,2}, Katie Humphreys¹ & Zoe Kourtzi¹ (¹School of Psychology, University of Birmingham, Edgbaston, Birmingham, B15 2TT, UK; ²Hertie Institute for Clinical Brain Research, Otfried-Müller-Strasse 27, 72076 Tübingen, Germany. Email: DXO655@bham.ac.uk)

Perceptual integration, the binding of local image features to a unified global percept lies at the core of visual perception. Traditional approaches to visual processing suggest that the analysis of local image features involves early occipital visual areas, while higher visual areas in the infero-temporal cortex mediate the perception and recognition of global shapes. Here we report an fMRI study that employed Glass patterns (geometrically arranged random dot patterns that give rise to different global percepts while having similar local features). We collected BOLD responses while observers (n=6) were presented with radial, concentric and linear Glass patterns as well as random dot patterns and performed a target (hyperbolic pattern) detection task. A fixed-effects group analysis revealed activation of occipito-temporal cortex for Glass vs. random patterns. Retinotopic and object-responsive visual cortex was mapped in each single subject according to standard techniques. Multivariate analysis of the

activation patterns in these Regions-Of-Interest (ROIs) revealed brain activation patterns with differential selectivity across global patterns already at the level of primary visual cortex. Importantly, the accuracy by which the classification of global patterns was predicted from activations patterns in occipito-temporal cortical regions increased while the number of voxels necessary for high classification accuracy was reduced along the cortical hierarchy. These findings suggest that perceptual integration of global patterns is implemented by increasingly selective and sparser encoding of visual features in the human brain.

Session 2

Disparity-defined shape discrimination correlates with both dorsal and ventral stream activity in the human brain

Andrew E. Welchman¹, Chandramouli F. Chandrasekaran² & Johannes C. Dahmen³ (¹School of Psychology, University of Birmingham, Birmingham, B15 2TT, UK; ²Department of Psychology, Princeton University, Princeton, NJ 08540-1010, USA; ³Department of Physiology, Anatomy and Genetics, Parks Road, Oxford, OX1 3PT, UK. Email: a.e.welchman@bham.ac.uk)

Binocular disparity provides an important cue to the three-dimensional structure of the environment. Sensitivity to disparity is evident at multiple levels of the visual hierarchy in the primate brain, from early visual cortex to parietal and temporal areas. However, the relationship between activity in these areas and key perceptual functions that exploit disparity information for 3D shape perception remains an important open question. Here we report experiments using fMRI measurements concurrent with psychophysical judgments aimed at investigating the link between human cortical activity and the perception of disparity-defined shape. Observers (n=10) viewed random dot stereograms depicting a global shape that had either a horizontal or vertical axis of symmetry. Their task was to identify the symmetry axis of the viewed figure. We manipulated task difficulty parametrically by randomly shuffling the spatial positions of dots whose disparity defined the global shape. This lowered the spatial coherence of the shape (while keeping image disparity constant), making it harder to appreciate the global structure, and thus to judge global symmetry. We investigated the effects of this stimulus manipulation on both cortical activity and shape discrimination performance. We observed significant relationships between shape coherence and fMRI response in both dorsal (V3, hMT+/V5) and ventral (LOC) visual areas that corresponded to the observers' discrimination performance. In contrast to previous suggestions of a dichotomy of disparity-related processes in the ventral and dorsal streams, these findings are consistent with proposed pathway interactions that may mediate a continuum of processes from coarse contour segmentation to fine curvature estimation.

Binocular summation is more tightly tuned to spatial frequency, orientation and spatial phase than interocular suppression

Daniel H. Baker, Tim S. Meese & Laura Patryas (School of Life & Health Sciences, Aston University, Aston Triangle, Birmingham, B4 7ET, UK. Email: bakerdh@aston.ac.uk)

Binocular vision involves at least two interactions between the eyes: interocular suppression and binocular summation. Both contribute to dichoptic masking, but the second also contributes to facilitation. Here we used a 2AFC contrast-masking paradigm and horizontal 1 c/deg target gratings (200 ms) to characterise the spatial properties of these two processes.

In Experiment 1, dichoptic masks were the same as the target but were either in-phase or out-of-phase. For in-phase masking, suppression was strong (log-log slope of ~ 1) at moderate mask contrasts and above, and there was weak facilitation at low mask contrasts. Anti-phase masking was weaker (log-log slope of ~ 0.6) and there was no facilitation. The in-phase function set the parameters of our model (Meese, Georgeson and Baker, 2006, *J. Vis.*, 6: 1224-1243), which predicted the anti-phase function when binocular summation was selective for phase, but interocular suppression was not. In Experiment 2, the spatial frequency and orientation tuning of both processes were measured using high-contrast dichoptic masks. By using masks in-phase and out-of-phase with the target we were able to decouple the masking produced by the two processes. Interocular suppression had an orientation bandwidth of $\sim \pm 30^\circ$, and a spatial frequency bandwidth > 2 octaves. Binocular summation was much more narrowly tuned with an orientation bandwidth of $\sim \pm 7.5^\circ$, and a spatial frequency bandwidth of ~ 0.5 octaves. Our results replicate the unusual shape of dichoptic tuning functions reported by Legge (1979, *Vis Res.*, 69: 838-847), which can now be seen as the envelope of two processes (interocular suppression and binocular summation).

Families of models for the "Gabor Path" paradigm

R. Watt¹, S. Dakin² & T. Ledgeway³ (¹Department of Psychology, University of Stirling, Stirling, FK9 4LA, UK; ²Institute of Ophthalmology, University College London, Bath Street, London, EC1V 9EL, UK; ³Department of Psychology, University of Nottingham, Nottingham, University Park, Nottingham, NG7 2RD, UK. Email: r.j.watt@stir.ac.uk)

It is possible to perceive a contour formed from aligned but separate gabor patches within a field of randomly placed and oriented gabors (Field, Hayes and Hess, 1993, *Vision Research*, 33 173-193). It is as if the gabors are (i) connected to each other and (ii) the curvature of the resultant contour is judged. It is found that an orientation difference from one target gabor to the next of up to 40 degrees is tolerated. The usual explanation for this phenomenon is an "association field". Gabors mutually enhance each other if they have prescribed spatial and orientation relationships. We have studied computationally and psychophysically the separate contributions of these two types of relation, spatial and orientation, to performance.

We present 4 different families of model, all of which are capable of explaining the results. (1) Delaunay triangulation to specify spatial connectivity in combination with curvature measurement. These models show similar variations in performance to the human data, although a little better. (2) Fixed distance connectivity models provide similar performance. (3) Association field models also behave similarly. (4) The simplest model family is based on the spatial overlap of responses from filters of different orientations.

Given that all models behave similarly to humans, despite some not having any selectivity for orientation relations, we conclude that the fundamental step in solving the gabor path task is the spatial relation one rather than the curvature judgement. Once gabors are linked, curvature statistics can be used to decide what is likely to be target and what is likely to be background.

Discriminating depth in stereo surfaces: dipper effect found, and lost

M. A. Georgeson¹, T. A. Yates¹ & A. J. Schofield² (¹School of Life & Health Sciences, Aston University, Aston Triangle, Birmingham, B4 7ET, UK; ²School of Psychology, Birmingham University, Birmingham, B15 2TT, UK. Email: m.a.georgeson@aston.ac.uk)

Measurement of detection and discrimination thresholds yields information about visual signal processing. For luminance contrast, we are 2-3 times more sensitive to a small increase in the contrast of a weak 'pedestal' grating, than when the pedestal is absent. This is the 'dipper effect' - a reliable improvement whose interpretation remains controversial. Analogies between luminance and depth (disparity) processing have attracted interest in the existence of a 'disparity dipper' - are thresholds for disparity, or disparity modulation (corrugated surfaces), facilitated by the presence of a weak pedestal? Lunn & Morgan (1997, JOSA A 14,360-371) found no dipper for disparity-modulated gratings, but technical limitations (8-bit greyscale) might have prevented the necessary measurement of very small disparity thresholds. We used a true 14-bit greyscale to render small disparities accurately, and measured 2AFC discrimination thresholds for disparity modulation (0.6 c/deg) of a random texture at various pedestal levels. Which interval contained greater modulation of depth? In the first experiment, a clear dipper was found. Thresholds were about 2x lower with weak pedestals than without. But here the phase of modulation (0 or 180 deg) was randomized from trial to trial. In a noisy signal-detection framework, this creates uncertainty that is reduced by the pedestal, thus improving performance. When the uncertainty was eliminated by keeping phase constant within sessions, the dipper effect disappeared, confirming Lunn & Morgan's result. The absence of a dipper, coupled with shallow psychometric slopes, suggests that the visual response to small disparities is essentially linear, with no threshold-like nonlinearity.

Mechanisms of probabilistic cueing in large-scale search

Alastair D. Smith, Bruce M. Hood & Iain D. Gilchrist (Department of Experimental Psychology, University of Bristol, 12a Priory Road, Bristol, BS8 1TU, UK. Email: Alastair.Smith@bris.ac.uk)

It has been argued (e.g. Klein & MacInnes, 1999, Psych Sci, 10 346-352) that the processes underlying visual search also support foraging behaviour in large-scale space. Learning of probabilistic properties of the array (e.g. Geng & Behrmann, 2002, Psych Sci, 13, 520-525), especially the likely target position, is a key element of visual search behaviour that one would predict to guide large-scale egocentric search, especially given the increased effort involved. We describe studies utilising an automated search apparatus in which participants search an array of lights for a hidden target by pressing switches at each location. In each of the experiments, the target appeared in one hemifield 80% of the time. Over 5 experiments we manipulated properties of the display to identify if: 1) participants are sensitive to statistical regularities, 2) they are explicitly aware of the regularity, 3) learning is based on an egocentric or allocentric coding of space, and 4) the role of environmental stability in learning. Participants explicitly learned target likelihoods when the array was constant throughout the experiment and starting location was fixed. They did not learn when room-based and body-based biases were dissociated. Stability of the array also affected performance, with less learning when the array was altered from trial to trial. These data suggest that statistical contingencies in the array must be coded consistently in both egocentric and allocentric coordinates in order to be utilised. Furthermore, this is more likely to occur if the probabilities can be fixed to stable elements in the array.

Efficient search for gross illumination discrepancies in upright but not inverted images of natural objects

P. G. Lovell¹, I. Gilchrist¹, D. Tolhurst² & T. Troscianko¹ (Department of Experimental Psychology, University of Bristol, 12a Priory Road, Bristol, BS8 1TU, UK; ²Department of Physiology, Development and Neuroscience, University of Cambridge, Downing Street, Cambridge, CB2 3EG, UK. Email: p.g.lovell@bristol.ac.uk)

Evidence from schematic stimuli (Rensink and Cavanagh, 2004 Perception, 33, 1339-1358) suggests that the detection of discrepant shadows in a visual search task is impaired in upright, but not inverted, images – hypothetically due to the discounting of shadows. This study investigates search with real objects and their shadows.

Pebbles were photographed with and without cast shadows. The visual difference between all pebbles (without shadows) was estimated using a visual difference predictor (Lovell et al 2006 ACMTAP, 3, 155). By selecting pebbles that were either visually similar or dissimilar we could to manipulate the heterogeneity of distractors.

Experiment 1: Visual search for a discrepant shadow 180° different from all others. The heterogeneity of distractors was manipulated. Stimuli were presented upright (light-from-above) or inverted (light-from-below). Search slopes became steeper with increased heterogeneity but only when images were inverted. This suggests that shadows are not "suppressed", but instead are coarsely processed - but only when light comes from above.

Experiment 2: The orientation of the target shadows was varied between 30 and 180°. At each orientation search intercepts were generally comparable when upright and inverted. However, at 30° the intercept was larger for upright images, suggesting a delay in the onset of the search process, perhaps explained by the handover of processing from the relatively coarse-scaled and insensitive shadow system to other general-purpose visual routines.

The results are consistent with a specific shadow processing module which (a) is spatially coarse, (b) is only activated when light appears to come from above, and (c) is not involved in any suppressive function.

Session 3

Is Global Motion processed by mechanisms that are monocular, binocular or both?

R. F. Hess¹, C. V. Hutchinson², T. Ledgeway² and B. Mansouri¹ (¹McGill Vision Research, Department of Ophthalmology, 687 Pine Avenue West, Montreal, Quebec, H3A 1A1, Canada; ²Nottingham Visual Neuroscience Group, School of Psychology, University of Nottingham, Nottingham, NG7 2RD, UK. Email: robert.hess@mcgill.ca)

This study investigates four key issues concerning the binocular properties of the mechanisms that encode global motion in human vision: (1) the extent of any binocular advantage; (2) the possible site of this binocular summation; (3) whether or not purely monocular inputs exist for global motion perception; (4) the extent of any dichoptic interaction. Global motion coherence thresholds were measured using random-dot-kinematograms as a function of the dot modulation depth (contrast) for translational, radial and circular flow fields. We found a marked binocular advantage of approximately 1.7, comparable for all three types of motion and the performance benefit was due to a contrast rather than a global motion enhancement. In addition, we found no evidence for any purely monocular influences on global motion detection. The results suggest that the site of binocular combination for global motion perception occurs prior to the extra-striate cortex where motion integration occurs. All cells involved are binocular and exhibit dichoptic

interactions, suggesting the existence of a neural mechanism that involves more than just simple summation of the two monocular inputs.

Decoding flexible representations for categorisation of movement sequences in the human brain

Sheng Li¹, Dirk Ostwald¹, Martin Giese² & Zoe Kourtzi¹ (¹School of Psychology, University of Birmingham, Edgbaston, Birmingham, B15 2TT, UK; ²Laboratory for Action Representation and Learning (ARL), University Clinic Tübingen, Schaffhausenstr. 113, 72072 Tübingen, Germany. Email: s.li.1@bham.ac.uk)

While much is known about the processing of simple visual motion in the human brain, the neural basis of visual categorisation of complex movements remains largely unknown. Using combined psychophysical and fMRI measurements we investigated whether we could decode the features/dimensions that observers use to categorise movement sequences from BOLD responses in cortical areas engaged in visual categorisation (fronto-parietal cortex and striatum) and occipitotemporal areas involved in the perception of global forms and motion. Using spatial morphing (between two prototypes: AB) and time-warping (between two temporal profiles: Slow-Fast and Fast-Slow), we generated a two-dimensional stimulus space of complex movements (dynamic point-light displays) that differed parametrically in their spatial arrangement and temporal profile. In two scanning sessions, observers categorised the same movement sequences either based on their visual similarity to prototypical movements (A vs. B) or a complex categorisation rule based on both visual similarity and temporal profile (A_Fast-Slow_or_B_Slow-Fast vs. A_SlowFast_or_B_FastSlow). Using multivariate pattern classification methods, we were able to predict the categorisation rule that the observers used in each session. In particular, we observed a significant interaction between the prediction accuracy of pattern classification based on the visual similarity rule and classification based on the complex rule across sessions in prefrontal areas (DLPFC, PMd, PMv), the striatum and the LOC. These findings suggest that visual categorisation shapes the selectivity of neural populations in these areas that mediate flexible representations of the critical features/dimensions for the discrimination of complex movements.

Facilitation, Uncertainty, and Noise

William McIlhagga (Vision Sciences Research Focus Group, Division of Optometry, University of Bradford, Bradford, BD7 1DP, UK. Email: w.h.mcilhagga@Bradford.ac.uk)

Facilitation occurs when a low contrast pedestal enhances detection of a superimposed test. Recently, Henning & Wichmann (2007, JoV, 7(1) 1-15) showed that adding noise at spatial frequencies different from the test frequency reduced or removed facilitation in contrast discrimination. They concluded that facilitation is a result of off-frequency looking. Here, I show that their results are better explained in terms of a modified uncertainty model. A common model of uncertainty, the max-detector, uses the maximum of the relevant and irrelevant detectors as a decision variable, so if detector $d(i)$ has standard deviation $s(i)$, the observer chooses $\max\{d(i)/s(i)\}$ as the decision variable. I suggest that noise over-suppresses detectors, so that the observer chooses $\max\{d(i)/s(i)^2\}$ or something similar. When notched noise is added to a discrimination task, this suppresses the irrelevant detectors more than the relevant detectors, thus reducing uncertainty and, by extension, facilitation. The noise-suppression model has one major consequence: when masking with

noise of various bandwidths, wider bandwidths of noise should have less effect on detection than narrow. This is in fact the case (Stromeyer and Julesz, 1972, JOSA 62(10) 1221-1232). In the noise over-suppression uncertainty model, this arises because wider noise bandwidths suppress the irrelevant detectors as well as the relevant, while narrower noise suppresses only relevant detectors.

The influence of fixation points on contrast detection of patches of grating

Robert J. Summers & Tim S. Meese (School of Life & Health Sciences, Aston University, Aston Triangle, Birmingham, B4 7ET, UK. E-mail: t.s.meese@aston.ac.uk)

The use of fixation points (FPs) in visual psychophysics is common practice. However, the effects of different fixation arrangements have not been investigated. We performed a temporal 2AFC contrast detection experiment for 100ms pulses of horizontal patches of sine-phase grating. Spatial frequency was 1,2,4 or 8c/deg at a viewing distance of 2.2m. Central targets were modulated by a circular raised-cosine envelope, producing 2 cycles at full-width, half-height. The experiment was blocked across spatial frequency and four fixation categories: (i) no FP, (ii) a central FP, (iii) a quad of FPs on the corners of a virtual square that surrounded the target, and (iv) a quad plus central FP. FPs were 2.6 arcmin wide and were visible throughout. Above 2c/deg, adding the central FP to the quad decreased sensitivity by ~3dB. For two observers, this was similar to adding a central FP to no FP. Effects were diminished or absent at 2c/deg and below. The slope of the psychometric function was always steep (Weibull ~3.5), implying that uncertainty was not a strong factor. As superimposed FPs remove some of the stimulus from view we tested the effect of superimposing a central square point (2.6 arcmin) of the target with background luminance. This had no effect on detection thresholds, suggesting that the effects from the central FP were due to suppression. Suppressive effects remained when the FPs were reduced to 1.3 arcmin (as small as practicable), but were diminished (~2dB). We recommend the use of quad FPs for small stimuli (≤ 1 deg).

A cross-modal aftereffect reveals merging of proprioception and vision

Marco Bertamini¹, Eleanor Thraves¹ & Nicola Bruno² (¹School of Psychology, University of Liverpool, Bedford Street South, Liverpool, L69 3BX, UK; ²Università di Trieste, Dipartimento di Psicologia & BRAIN Center for Integrative Neuroscience, Via S. Anastasio 12, 34134 Trieste, Italy. Email: M.Bertamini@liverpool.ac.uk)

We used the visual-proprioceptive Ames window (Bruno et al., 2006, Perception, 35, 25-30) to produce a cross-modal aftereffect. The Ames window is a trapezoid perceived as a slanted rectangle. Participants held a window (ratio of long:short sides: 1.9) in their hands. After describing the visual illusion they also experienced that one arm was longer than the other. Immediately afterwards, participants were asked to position their hands at equal distances, with their eyes closed. A control group saw the same stimulus and a similar visual illusion, but without holding the window and therefore without experiencing an effect in their arms. The visual-proprioceptive Ames window produced a positional aftereffect: when participants tried to place their hands at equal distances they moved the "short arm" hand farther than the "long arm" hand. This crossmodal aftereffect takes place after a relatively brief presentation (less than four minutes), and without explicit feedback during exposure. These properties are consistent with a mandatory crossmodal merging mechanism for the position of one's limbs in space.

Graphics, memory, and surrealism – an experimental investigation

Tom Troscianko¹, Nick Mourkoussis², Fiona Rivera², Katerina Mania², Tim Dixon¹, Rycharde Hawkes³ (¹Department of Experimental Psychology, University of Bristol, UK; ²Dept Informatics, University of Sussex; ³Hewlett Packard Laboratories, Bristol, UK. Email: tom.troscianko@bristol.ac.uk)

Schema theory proposes that memory for objects in scenes depends on the degree to which the objects appear to belong to a particular scene (consistent objects) or not (inconsistent objects). However, the degree to which an object will be consistent with a scene is likely to depend on whether the perception of the scene is itself consistent with our previous experience. Thus, for example, if a familiar scene is presented in an unfamiliar manner (“surreal”), the effect of object consistency on memory is likely to change. We wished to see whether this kind of effect can be used to investigate the degree to which a virtual environment (VE) is perceived as “normal”, i.e. consistent with our usual experience of similar environments, or “abnormal/surreal”, i.e. markedly different from our previous experience. Two initial studies measured the effect of rendering quality on memory for consistent and inconsistent objects in conditions of varying quality of radiosity (Experiment 1) and polygon count (Experiment 2). Participants interacted with the scenes wearing VGA resolution, head-tracked HMDs. They were then tested for memory for inconsistent and consistent objects. There was little effect of rendering quality except in one condition in which individual objects were hard to recognize. Experiment 3 therefore used a more extreme set of rendering types: wireframe with added color, and full radiosity. The proportion of inconsistent/consistent objects was varied, and object recognition tests ensured that all objects were easily recognized in all conditions. The results showed a significant three-way interaction between rendering type, object type, and consistency ratio. This suggests that inconsistent objects are only preferentially remembered if the scene looks “normal” or if there are many such objects in an “abnormal/surreal” scene. We conclude that memory for objects can be used to assess the degree to which the context of a VE appears normal.

Posters (in alphabetical author order):

The spatial tuning of the Hermann grid illusion in observers with primary open-angle glaucoma.

Jose B. Ares-Gomez, Michael J. Cox, Ian E. Pacey, Anita Reynolds*, James M. Gilchrist & Ganeshbabu T. Mahalingam (Department of Optometry, University of Bradford, Bradford, BD7 1DP, UK; *Ophthalmology Department, Bradford Royal Infirmary, NHS Foundation Trust, Bradford, BD9 6RJ, UK. email: J.B.Aresgomez@Bradford.ac.uk)

Purpose: Glaucoma is a progressive optic neuropathy characterised by retinal ganglion cell death, characteristic physiological and anatomical changes in the optic disc and associated visual field defects. Glaucomatous observers could serve as an ideal means to test the potential modulation of the Hermann grid illusion (HGI) due to retinal changes. Consequently, the capability of a new localised Hermann grid methodology for the detection and assessment of localised glaucomatous damage was evaluated, and second, data obtained in the investigation provided evidence about the location where the HGI is generated.

Methods: A computer-based psychophysical test measured the intensity of the light-patch that nulled the HGI at different bar widths (3.61-44.52 arcmin) for two different retinal eccentricities (1.5 and 3 deg) in three observers with primary open angle glaucoma (POAG). Test locations were close to regions that presented characteristic visual field defects and/or retinal nerve fibre layer defects as assessed by Humphrey visual field perimetry and scanning laser polarimetry (GDx-VCC), respectively. Control locations used equivalent normal retinal areas.

Results: The results presented by POAG observers were mixed, with one observer producing inconsistent results. An abnormal spatial tuning of the HGI was noted in another observer in visual field locations where normal conventional anatomical and functional responses were found.

Conclusions: The localized Hermann grid methodology could be capable of predicting future anatomical and psychophysical deficits measured by other clinical tests such as Humphrey visual field perimetry and scanning laser polarimetry. The most reliable of these data support the hypothesis of a significant retinal contribution to the origin of the HGI.

Bee SLAM: A probabilistic framework for studying orientation flights in bees and wasps

Bart Baddeley & Andrew Philippides (Centre for Computational Neuroscience and Robotics, School of Life Sciences University of Sussex, Brighton, BN1 9QG, UK. Email: B.T.Baddeley@sussex.ac.uk, andrewop@sussex.ac.uk)

When bees and wasps leave the nest to forage, they perform orientation or learning flights (Collett and Zeil, 1996, J. Comp. Physiol. A, 5(5):149-155). This behaviour includes a number of stereotyped flight manoeuvres which could mediate the active acquisition of visual information by, for instance, reducing variation in movement and producing strong motion parallax. Assuming that bees or wasps are attempting to localise themselves in the world with reference to stable visual landmarks, then the orientation flight can be modelled as a probabilistic Simultaneous Localisation And Mapping (SLAM) problem (Davison and Murray, 2002, IEEE Trans. Patt. Anal. Mach. Intell., 24(7):865-880). Within this framework, stereotypical behaviour makes the agent's own movements easier to predict, which in turn leads to better localisation and mapping performance. We describe a probabilistic framework

for building quantitative models of orientation flights. We show that a reliable movement model allows the animal to orient itself relative to a set of fixed landmarks efficiently. We further show that having learnt the relative positions of landmarks, animals can re-orient at a later stage drastically reducing the error in their estimated position. Finally, we discuss how this approach can be used to analyse visual learning behaviours in bees.

Contrast transduction within suppressive pathways is almost linear for monoptic, dichoptic and binocular cross-channel masking

Kirsten L. Challinor, Tim S. Meese, Robert J. Summers, Sonal P. Jagatia & Mark A. Cooper (School of Life & Health Sciences, Aston University, Aston Triangle, Birmingham, B4 7ET, UK. Email: t.s.meese@aston.ac.uk)

Recent psychophysical work has revealed multiple pathways for cross-orientation suppression in human vision. In particular, ipsiocular and interocular pathways were found to impact before binocular summation but to have different: (i) spatial tuning functions, (ii) temporal dependencies, and (iii) adaptation after-effects (Baker et al, 2007, Neuroscience, in press). Here we investigate the pooling processes for multiple mask components within these pathways. We measured contrast-masking functions for vertical 1c/deg sine-wave gratings (diameter of 4.5 deg) in the presence of left or right oblique ($\pm 45^\circ$) 3c/deg mask gratings with contrast C%, or a plaid made from their sum, where each component (i) had contrast 0.5C (C = 0-45%). Stimulus duration was 100 ms. Masks and targets were presented to: two eyes (binocular), one eye (monoptic) or different eyes (dichoptic). Unstimulated eyes always saw mean luminance (20 cd/m²). Binocular summation at threshold was normal (~ 4.2 dB), and binocular-masking functions superimposed when plotted against C, confirming 'linear suppression' (perfect linear summation of mask contrasts, C) for this condition (Holmes & Meese, 2004, J Vis, 4, 1080-1089). For both monoptic- and dichoptic-masking, the grating produced about 1.1dB more suppression than the plaid. This is consistent with a gently accelerating transducer exponent (< 1.4) on the mask component contrasts before their summation and divisive suppression of the target. None of the results were consistent with suppression by the contrast energy of the mask. In any case, suppressive pooling within ipsiocular and interocular pathways follows a common rule, deviating only slightly from linearity.

Perceiving and drawing ambiguous figures in Autism spectrum disorder

Gowen¹, E. & Miall², R.C. (¹Faculty of Life Sciences, Moffat Building, The University of Manchester, P O Box 88, Sackville Street, Manchester, M60 1QD, UK; ²T Behavioural Brain Sciences, School of Psychology, University of Birmingham, B15 2TT, UK. Email: emma.gowen@manchester.ac.uk)

Autism spectrum disorder (ASD) is characterised by impaired social interaction and such individuals display altered processing of human and social stimuli. In the current work we used ambiguous figures (AF) that could have either a human/social interpretation or a non-human interpretation (e.g. the faces/vase AF) to further explore these deficits. As perception of AF can be influenced by higher level cognitive processes such as prior experience we predicted that individuals with ASD would perceive the non-human interpretation (vase) more frequently than control participants. In addition, as drawing strategy can change according to the AF interpretation (chosen start and end points differ) we hypothesised that ASD individuals would demonstrate a drawing strategy biased towards the non-human

interpretation. We tested this on 12 ASD individuals and 12 matched controls, using 24 AF presented individually on a Wacom drawing tablet. Subjects were initially instructed to indicate their preferred perceptual interpretation in a forced choice manner for each AF. This was followed by the drawing task where they were required to draw each randomly presented AF according to the instructed interpretation. Each AF was presented twice (once for each interpretation). Results indicated that perceptual interpretation and drawing strategy of individuals with ASD was not biased towards the non-human interpretation. However, ASD individuals more frequently drew the AF using the same strategy regardless of instructed interpretation, suggesting a less flexible approach, whereby the perceptual requirements of the task were overridden by prior motor experience.

Selective Mechanisms for Simple Contours Revealed by Adaptation

Sarah Hancock & Jon W. Peirce (School of Psychology, University of Nottingham, Nottingham, NG7 2RD, UK. Email: sarah.hancock@nottingham.ac.uk)

Previous studies demonstrated that a straight test stimulus can appear concave after exposure to a convex adapting stimulus. However, these studies were unable to determine whether the effect reflected a 'curvature aftereffect' or simply the combination of local tilt aftereffects (TAE) for small segments of the curve (Blakemore & Over, 1974, Perception, 3, 3-7). A curve could be modeled very simply as a contour formed from two differently oriented component segments. Here we used a method of compound adaptation to study the integration of Fourier components into contours. Two patches of the visual field were adapted to the same two component gratings oriented ± 10 degrees from vertical, presented one above the other. In one patch the two components were presented simultaneously as a contour (alternating with a blank field). In the other patch the components were presented alternately. Each component produces an individual TAE so that a straight, vertical probe stimulus spanning both components appears to curve in the opposite direction from the adapting stimuli. As both adapting patches contain the same components they should produce equivalent TAEs. However, the apparent curvature was greater in the patch where the components were presented together as a contour. This suggests that the TAE was accentuated in the contour patch by a contour aftereffect, not explained by local tilt aftereffects, a result consistent with the existence of 'curvature detectors'. The mechanism could be envisaged as a logical AND gate that responds only when both components of the contour are present.

The contrast-dependence of behavioural response latencies to different varieties of motion

Claire V. Hutchinson & Tim Ledgeway (Visual Neuroscience Group, School of Psychology, University of Nottingham, Nottingham, NG7 2RD, UK. Email: lpxcvh@psychology.nottingham.ac.uk)

This study measured the effect of stimulus contrast (modulation depth) on forced-choice reaction times for discriminating the drift-direction of first-order (luminance-modulated dynamic noise) and second-order (contrast-modulated, polarity-modulated, orientation-modulated and spatial length-modulated dynamic noise) motion. Results showed that, for all motion patterns, reaction times decreased as stimulus contrast increased. In general, reaction times were fastest for first-order motion (luminance), similar for some types of second-order motion (contrast, polarity, orientation) and markedly slower for others (spatial

length). The rate at which reaction times decreased as stimulus contrast increased was shallowest for luminance, similar for contrast, polarity and orientation and steepest for spatial length. When equated in terms of visibility (multiples of direction-discrimination threshold), the extent to which reaction times decreased as stimulus contrast increased became comparable for patterns defined by luminance, contrast, polarity and orientation. Nevertheless, for patterns defined by spatial length, performance could not be equated in this manner. In terms of the speed of responses, even when equated in terms of visibility, for the most part reaction times for first-order (luminance-defined) motion remained faster than for any of the second-order motion patterns. These findings demonstrate that the time taken to encode the direction of each pattern is not an invariant response metric and are consistent with psychophysical and electrophysiological evidence for longer response latencies for second-order motion which may be due to the additional processing stages (e.g. filter-rectify-filter) required for its extraction.

Stepping adaptations when negotiating a raised surface: a comparison between multifocal and single vision spectacles in the elderly

Louise Johnson, John G. Buckley, Clare Harley & David B. Elliott (Vision and Mobility Laboratory, Division of Optometry, University of Bradford, Bradford, BD71DP, UK. Email: L.Johnson4@Bradford.ac.uk)

Background: When negotiating uneven terrain, foot placement and adequate toe clearance are critical and are guided by visual information (Patla and Vickers 2003, Exp Brain Res, 1, 133-138). This study determined the effects of wearing multifocal compared to single distance vision spectacles in the elderly upon stepping characteristics and toe clearance parameters when negotiating a raised surface.

Method: Nineteen older adults (mean 72.7 yrs \pm 4.2 yrs) approached and stepped up and along a raised platform (14.9 cm high), the height of which was randomly increased by 1.0 cm or decreased by 0.6 cm every fourth trial, whilst wearing bifocal, varifocal or single distance vision spectacles.

Results: When wearing multifocal compared to single distance vision spectacles the trail limb was placed significantly further from the platform. Consequently the lead foot crossed the raised edge later in swing phase and the foot landed closer to the step edge. Vertical toe clearance and ankle dorsi-flexion also increased. Forward velocity during the penultimate and crossing steps reduced, and there was an increased incidence of 'inadvertent' heel-step contacts.

Conclusions: Adaptations to toe clearance and foot placement strategies were employed when wearing multifocal compared to single distance vision spectacles. This suggests that optical effects inherent in multifocal design result in unreliable visual information regarding the exact location and dimensions of a raised edge. Although the adaptations utilised ensured increased vertical toe clearance, the increase in heel contacts (which unlike a toe contact would likely not result in a trip) suggest subjects may have adopted this strategy to increase proprioceptive feedback.

Attentional effects on colour-based global motion processing

Jasna Martinovic^{1,2}, Sophie Wuerger¹ & Georg Meyer¹ (1School of Psychology, Bedford Street South, University of Liverpool, Liverpool L697ZA, UK; 2Institute for Experimental Psychology, University of Leipzig, Seeburgstraße 14-20, 04103 Leipzig, Germany. Email: s.m.wuerger@liverpool.ac.uk)

Global motion extraction in human observers does not automatically benefit from correlations between colour and motion but improvements in performance do occur when exogenous or endogenous attention is deployed. But what is the nature of this attentional enhancement? For a wide range of spatial and temporal parameters, chromatically-defined global motion processing relies solely L and M cone inputs (Ruppertsberg et al, 2003, Vis. Neurosc. 20, 421-428). We generated two-coloured Random Dot Kinematograms (RDKs, 'orange' and 'red-purple' blobs): these colours had the same L-M coordinates and differed only in S-cone signal. Under such conditions where S cones do not contribute to motion, S-cone signals still contribute to colour appearance, hence allowing the visual system to segment the RDK into surfaces. Both colour contrasts were fixed at threshold, to ensure equal effectiveness for motion extraction. Participants were asked to discriminate between coherent and random motion and d' was measured for 3 different conditions: 'uncorrelated' (=no colour-motion correlation), 'uncued correlated' and 'cued correlated'. The cue was presented shortly before the RDK and the colour of the cue indicated which colour in the RDK carried the coherent motion signal. The study confirmed that correlation does not automatically improve performance, as no differences in motion discrimination were found between uncorrelated and uncued correlated RDKs. Small but significant improvements in performance were found for cued correlated RDKs. This can be fully ascribed to surface-based attentional modulation. We conclude that attentional modulation cannot have acted on the motion signal per se, but must have restricted global motion processing to the relevant colour plane hence increasing the signal-to-noise ratio.

A motor-specific bias with veridical perception.

D. R. Melmoth, M. S. Tibber & M. J. Morgan (The Henry Wellcome Laboratories for Vision Sciences, Dept. of Optometry and Visual Science, City University, Northampton Square, London, EC1V 0HB, UK. Email: D.Melmoth@city.ac.uk)

We investigated the effect of the Poggendorff illusion (∟) upon perceptual judgements – moving an on-screen dot on the 'landing line' to the extrapolated point of intersection of the oblique transversal 'pointing line' (∟); and upon motor behaviour – manually pointing to the extrapolated intersection. Both perceptual and motor tasks were affected approximately equally (~2.5° error) by introduction of the Poggendorff inducing line. However, motor performance demonstrated an additional error (~1.5°), which was not evident for perception, that occurred in the presence of the oblique pointing line (∟) alone and was additive to the inducer-effect, resulting in an overall error in motor response that was actually larger than the perceptual error.

This motor-specific bias appears to be mediated by the landing line. Our tentative hypothesis is that when subjects are required to point to the extrapolated intersection of the oblique transversal (∟) with the landing line (∟), they underestimate required movement in the unknown dimension, relative to the start position. When the landing line is vertical (∟), and thus the correct x-shift is known, subjects under-estimate the y-shift and reach too high. When the landing line is horizontal (—), and thus the correct y-shift is known, subjects underestimate the x-shift and reach to the left of the veridical intersection point. However, when the

landing line is placed orthogonally to the transversal pointer (\sphericalangle), and thus neither the correct x- nor y-shift is provided, the additional motor-specific bias disappears and biases for the motor task become comparable with the perceptual task.

Summation of retinal after-effects and cortical mechanisms in contrast adaptation

M. Ozolinsh & D. Lauva (Department of Optometry and Vision Science, University of Latvia, 8 Kengaraga Str., LV-1063 Riga, Latvia. Email: ozoma@latnet.lv)

We investigated perception of Gabor gratings after adaptation to high contrast gratings. Four symmetrically positioned achromatic and R, G and B adaptation Gabor stimuli were presented for 8 sec on a monitor. After that a lower contrast test stimulus – one Gabor grating of the same spatial frequency and direction - was presented spatially coinciding with one of the previously demonstrated gratings of the adaptation stimuli. Subjects had to detect the position of the test stimulus.

We measured two time parameters: the time of recovery of retinal aftereffects (RRA) and the instant of appearance of the test stimuli (ATS time). When test and adaptation gratings were spatially in-phase, we observed a weak diminishing of RRA (0.6-0.8s) and a pronounced decrease in ATS times (7 to 2s) when the contrast of the test stimuli increased up to 70%. When test and adaptation gratings were spatially in counterphase (i.e., the retinal aftereffect image in phase with the modulation of the test stimuli attenuated by adaptation) RRA time revealed a slight increase with test stimulus contrast. To separate cortical mechanisms and retinal effects in contrast adaptation, red and green colour filters were used for the right and left eye, and adaptation and test stimuli were presented - red and green, correspondingly. Thus the right eye was contrast adapted, but the ATS time was measured for the non-adapted left eye only. Results were qualitatively similar to the previous results, confirming the high contribution of cortical mechanisms in contrast adaptation. Measurements for monochromatic (R,G,B) stimuli did not reveal significant differences in ATS and RRA time values.

Processing patterns during feature and conjunction search in Alzheimer's disease: evidence from eye movements and pupil dilation

Gillian Porter, Andrea Tales, Gordon Wilcock, Judy Haworth, Tom Troscianko & Ute Leonards (Department of Experimental Psychology, University of Bristol, 12a Priory Road, Bristol, BS8 1TU, UK. Email: Gillian.Porter@bristol.ac.uk)

Although there is evidence that patients with Alzheimer's disease (AD) are disproportionately impaired in their response speeds when performing conjunction relative to feature search tasks (Tales et al., 2002, *Neuropsychologia*, 40, 1849-1857), such differences are not large and it is unclear which stages of processing may be affected. Here we compared AD patients (mean age 79.6 years) with healthy elderly controls (mean age 78.7 years) on a conjunction search and two slow inefficient feature search tasks. The tasks were closely matched for difficulty in young participants. During performance we studied participants' eye movements as a measure of how the visual information was sampled, and pupil dilation, known to be sensitive to moment-to-moment processing effort. Reaction times replicated previous reports, with the AD group particularly slowed on conjunction relative to feature tasks, especially for target-absent trials. The eye movement data reflect this pattern, with AD patients making both more saccades and longer fixations than controls, particularly in the conjunction condition. Pupil dilation data, however, did not differ by task for AD patients or

controls, although controls showed more dilation during target-absent than target-present trials whereas the AD group did not. Thus, here AD appears to impair information input, especially when information must be combined across dimensions, but not the relative effort to process the sampled information then required by different task types. These data also provide physiological evidence that patients with AD are less able than healthy controls to increase effort in situations where there is not yet any tangible signal of success.

Texture segmentation disrupts the perception of shadows

Andrew J. Schofield¹ & Frederick A.A. Kingdom² (¹School of Psychology, The University of Birmingham, Edgbaston, Birmingham, B15 2TT, UK; ²McGill Vision Research, McGill University, 687 Pine Av West, Montreal, H3A 1A1, Canada. Email: a.j.schofield@bham.ac.uk)

Shadows provide important information about the depth, shape and the movement of objects in the visual scene. However, shadows, which are principally luminance variations, need to be distinguished from variations in luminance due to reflectance changes. Reflectance changes typically occur at object boundaries and are often accompanied by changes in other surface properties such as colour and texture. Here we concentrate on the role of visual texture, when defined in terms of oriented small-scale luminance variations on an object's surface. In a 2IFC task, observers were presented with discs divided into three sectors of different mean luminance. A circular shadow (multiplicative luminance decrement) was imposed at the centre of each disc. In one interval all the luminances in the shaded region were reduced by the same factor. In the other interval one sector was subject to a different amount of shading than the other two. Observers were asked to identify the interval in which all sectors were subject to the same degree of shading. Performance was best in the uniform texture condition suggesting that this reinforces the interpretation of luminance boundaries as shadow borders. Relative to the uniform texture case, shadow judgements were inhibited by the introduction of texture boundaries. Texture boundaries that were coincident with the circular luminance boundary associated with the shadow reduced performance. Texture boundaries that did not interfere with this key luminance border also reduced performance but were most disruptive when not aligned with any luminance border.

Identification of positive and negative emotional valence in four categories of pictures in a forward-backward masking paradigm

Lynda J. Shaw & Michael J. Wright (Centre for Cognition and Neuroimaging, Brunel University, Uxbridge, UB8 3PH, UK. Email: Michael.Wright@brunel.ac.uk)

Identification of positive and negative emotional valence was measured with and without conscious report of visual stimuli. A forward and backward masking paradigm was used to prevent conscious perception of target stimuli without eliminating subliminal processing, whereby the participants might 'guess' but still perform better than chance in detection and discrimination. The emotional target (10ms) was sandwiched between two neutral stimuli (150ms). Control trials consisted of only two 150ms neutral stimuli. Targets were valence-rated pleasant and unpleasant faces, animals, scenes and inanimate objects (IAPS) (Lang, Bradley & Cuthbert 2005). Observers (n=217) indicated by questionnaires whether they thought the display contained two or three stimuli, and whether the overall impression was pleasant or unpleasant.

“Target unseen” trials (37%) were those where the target was present and the number of stimuli reported was two. False positive trials (5.8%) were control trials where three stimuli were reported. Observers also gave confidence ratings of their impressions of valence (impression confidence), and of their judgment of the number of stimuli present (seen confidence). Even though there was a strong bias towards pleasantness responses, concordant identification of positive and negative emotions was significant for not-seen targets of all 4 categories. Seen confidence was a significant predictor of valence identification in only 7/24 stimuli, whereas impression confidence was significant in 15/24 stimuli. This experiment shows that detection of valence in unreported, brief masked presentations is not confined to limited classes of images such as faces.

Mach Edges: A critical test of the nonlinear 3rd derivative model for edge-detection

Stuart Wallis & Mark Georgeson (School of Life & Health Sciences, Aston University, Aston Triangle, Birmingham, B4 7ET, UK. Email: wallissa@aston.ac.uk)

Feature detection is a crucial stage of visual processing. Our previous feature-marking experiments found that peaks in the 3rd derivative of the luminance profile can signify edges where there are no 1st derivative peaks nor 2nd derivative zero-crossings (Wallis & Georgeson 2007, Perception 36, 314-315). These results on 'Mach edges' (the edges of Mach bands) were nicely predicted by a new non-linear model based on 3rd derivative filtering. As a critical test of the model, we now use a new class of stimuli, formed by adding a linear luminance ramp to the blurred triangle waves used previously. The ramp has no effect on the second or higher derivatives, but the nonlinear model predicts a shift from seeing two edges to seeing only one edge as the added ramp gradient increases. In experiment 1, subjects judged whether one or two edges were visible on each trial. In experiment 2, subjects used a cursor to mark perceived edges and bars. The position and polarity of the marked edges were close to model predictions. Both experiments produced the predicted shift from two to one Mach edge, but the shift was less complete than predicted. We conclude that the model is a useful predictor of edge perception, but needs some modification.