

Vision Researchers Colloquium

Tuesday 3rd July 2018

Queen's Building, University of Bristol

**Keynote by Jenny Read
Professor of Vision Science
Newcastle University**

In partnership with:



Vision Researchers Colloquium 2018

Programme

09:00	Registration, tea and coffee
09:30	Welcome by BVI Director, Professor David Bull
	Chaired by Professor Innes Cuthill, University of Bristol
09:35	Kjernsmo, Karin, University of Bristol: Iridescence as camouflage? Impaired object recognition in bumblebees
09:55	Daly, Ilse, University of Bristol: Complex gaze stabilisation in mantis shrimp
10:15	Robert, Theo, University of Exeter: Flexibility in bumblebees learning flights
10:35	Talas, Laszlo, University of Bristol: The “Camouflage Machine”: Optimising patterns for camouflage and visibility
10:55	Break – tea and coffee
	Chaired by Professor Darren Cosker, University of Bath
11:15	Saquil, Yassir, University of Bath: Generative models for semantic data exploration
11:35	Gale, Ella, University of Bristol: Characterising and manipulating the learned representation of visual data in deep-neural networks trained to classify images
11:55	Kangin, Dimitry, University of Exeter: Reinforcement learning for vision-based control
12:15	Masullo, Alessandro, University of Bristol: CaloriNet: From silhouette to calorie estimation in private environments
12:35	Lunch and poster presentations
	Chaired by Dr Natalie Hempel de Ibarra, University of Exeter
14:00	Keynote: Jenny Read, Professor of Vision Science, Newcastle University: Of mantids and men: Stereoscopic (3D) vision in humans and insects
15:00	Zappala, Stefano, Cardiff University: Investigation of the mechanics underlying brain shift: an image-based approach for the measurement of the in-vivo deformation of the brain
15:20	Hunt, Edmund, University of Bristol: Asymmetric eyes and behavioural lateralization
15:40	Lévêque, Lucie, Cardiff University: An eye-tracking study with mammograms
16:00	Blything, Ryan, University of Bristol: Translating invariance in vision
16:20	Closing the colloquium
16:30	Informal drinks reception

Posters

	Name
1	Bok, Michael – University of Bristol: Looking with gills: The diverse, distributed visual systems in fan worms.
2	Brodrick, Emelie – University of Bristol: Crustacean vision: adaptable eyes for extreme changes in light
3	Burtan, Daria – University of Bristol: Image aesthetics, not basic image statistics, affect human gait parameters
4	Clark, Rosie – University of Bristol: What can eye-tracking tell you about a child's pursuit eye movements that an orthoptist can't? Pilot study
5	Costello, Leah – University of Bristol: The use of 'false holes' in camouflage
6	Crellin, Eleanor – University of Bath: Can motion graphs be used for quadrupedal animation?
7	Di Martino, Alessandro – University of Bath: Gaussian process deep belief networks: a smooth generative model of shape with uncertainty propagation
8	Dyke, Roberto – Cardiff University: Non-rigid registration under anisotropic deformations
9	Fan, Liang - Cardiff University: An improved Siamese network for face sketch recognition
10	Fernandez Alonso, Mariana – University of Bristol: A study of subjective video quality at various spatial resolutions
11	Galloway, Jim – University of Exeter: The role of diet vs vision in chameleon prawn colour change
12	Harris, David – University of Exeter: Examining the role of visual attention in multiple object tracking expertise
13	Hartley, Thomas – Cardiff University: Self-pruning CNNs using predicted filter salience
14	He, Sen - University of Exeter: What catches the eye? Visualizing and understanding deep saliency models
15	Katsenou, Angeliki – University of Bristol: Perceptually-aligned frame rate selection using spatio-temporal features
16	Latham, Jack – Cardiff University: Localisation and assessment of Doppler ultrasound cardiac output scans
17	Lim, Anna – University of Bristol: Iridescence as a deceptive anti-predator strategy
18	Ma, Di - University of Bristol: Developing a parameterisable synthetic video dataset for analysis and compression purposes
19	Matchette, Samuel – University of Bristol: Concealment in a dynamic world: dappled light and caustics mask movement
20	Meah, Rochelle – University of Bristol: Evolutionary responses to anthropogenic light – phenotypic shifts in retinal specializations
21	Motala, Aysha – Cardiff University: Visual rhythm perception – simply the sum of its parts?

22	Muchhala, Mubaraka - University of Bristol: The effect of dichromatic representation on affective image perception
23	Ponce Lopez, Victor – University of Bristol: Semantically selective augmentation for deep compact person re-identification
24	Smithers, Samuel – University of Bristol: Seeing the world in a different light – visual processing of intensity and polarization to enhance target detection
25	Sullivan, Brian – University of Bristol: Detecting uncertainty in a natural task
26	Wainwright, Benito – University of Bristol: Camouflage vs. symmetry: a battle between selective forces
27	Ward, Amy – University of Bristol: Investigating inflammatory eye disease
28	Wells, Mason – Cardiff University: Mapping residual visual function in hemianopia
29	Zhang, Fan – University of Bristol: A video quality metric for spatial resolution adaptation

Keynote Lecture

Jenny Read

Professor of Vision Science

Newcastle University

Of mantids and men: Stereoscopic (3D) vision in humans and insects

Abstract

People used to think stereoscopic “3D” vision was restricted to a few “higher” mammals such as primates and cats. However, we now know it has evolved independently in several taxa, including mammals, birds, amphibians and at least one insect: the praying mantis.

Mantids are the only invertebrates known to possess stereo vision, so it’s particularly interesting to understand how their stereo works and whether it is similar to our own. Professor Jenny Read will review what is known about stereoscopic vision in humans and other animals and describe recent work from her lab suggesting that insect stereo vision works very differently from our own.

Biography

Jenny Read is Professor of Vision Science at Newcastle University’s Institute of Neuroscience. She has a first-class degree in physics (1994), a doctorate in theoretical physics (1997) and a Masters in neuroscience (1999), all from Oxford University, UK.

From 1997-2001 she was a Wellcome Training Fellow in Mathematical Biology at Oxford University, then from 2001-2005 a postdoctoral fellow at the US National Eye Institute. She returned to the UK in 2005 with a University Research Fellowship from the Royal Society, Britain’s national science academy.

Her lab works on many aspects of visual perception, especially stereoscopic or “3D” vision. Current projects include modelling how visual cortex encodes binocular information, developing a new stereo vision test for children (<http://research.ncl.ac.uk/asteroid/>), and uncovering how insects see in stereoscopic 3D (<http://www.jennyreadresearch.com/research/m3/>).

More information and all publications are available at www.jennyreadresearch.com



Presentations

Session 1 – Chair, Professor Innes Cuthill, University of Bristol

Presentation 1

Kjernsmo, Karin, University of Bristol

Iridescence as camouflage? Impaired object recognition in bumblebees

Protective colouration in animals, including various forms of camouflage, aposematism and mimicry, provides several ways for prey to escape predation. However, the adaptive function of one particular colouration, iridescence, is not yet fully understood. Iridescence is a non-pigment based form of structural colour, generated by nanostructures which produce highly reflective, directional colours that shift with changing angle of view or angle of illumination. This variability can make objects more conspicuous, but the changing colour patterns may also deceive and confuse potential predators by obstructing target identification. Using artificial flowers as prey targets and bumblebees (*Bombus terrestris*) as visual predators, we tested whether iridescence could obstruct target identification and, as a result, decrease predation risk. Our results show that bees found it more difficult to discriminate between target shape when targets were iridescent compared to non-iridescent. We conclude that iridescence produces visual signals that can confuse potential predators, and this might explain the high frequency of iridescence in many animal taxa.

Kjernsmo K, Hall J, Cuthill I, Scott-Samuel N & Whitney H

Presentation 2

Daly, Ilse, University of Bristol

Complex gaze stabilisation in mantis shrimp

Almost all animals, regardless of the anatomy of the eyes, require some level of gaze stabilization in order to see the world clearly and without blur (Land 1999). For stomatopods (commonly known as mantis shrimp), achieving gaze stabilization is unusually challenging as their eyes have an unprecedented scope for movement in all three rotational degrees of freedom: yaw, pitch and torsion (Jones, 1994; Daly et al., 2017). I will present the findings of a set of experiments examining the three-dimensional gaze stabilization response in the species *Odontodactylus scyllarus*.

While *O. scyllarus* does perform stereotypical gaze stabilization in the yaw degree of rotational freedom, these stabilizing movements are accompanied by simultaneous changes in the pitch and torsion rotation of the eye. Surprisingly, yaw gaze stabilization performance is unaffected by both the torsional pose and the rate of torsional rotation of the eye. Further to this, we found a lack of a torsional gaze stabilization response in the stomatopod visual system (Daly et al., 2018).

In the light of these findings, we suggest that the neural wide-field motion detection network in the stomatopod visual system may follow a radially symmetric organization to compensate for the potentially disorientating effects of torsional eye movements, a system likely to be unique to stomatopods. I will also discuss ongoing work investigating the function of the extreme rotational range of the stomatopod eye, which follows on from these surprising results.

Daly, I

Land, M. F. (1999), Motion and vision: why animals move their eyes, *Journal of Comparative Physiology A*, 185, 341–352.

Jones, J. (1994), Architecture and composition of the muscles that drive stomatopod eye movements, *Journal of Experimental Biology*, 188, 317-331.

Daly, I. M., How, M. J., Partridge, J. C., Roberts, N. W. (2017), The independence of eye movements in a stomatopod crustacean is task dependent, *Journal of Experimental Biology*, 220, 1360-1368

Daly, I. M., How, M. J., Partridge, J. C., Roberts, N. W. (2018), Complex gaze stabilization in mantis shrimp, *Proceedings of the Royal Society B*, 285, 20180594

Presentation 3

Robert, Theo, University of Exeter

Flexibility in bumblebees learning flights

When departing their nest or a flower, bumblebees perform learning flights that allow them to scan and learn the visual surroundings of the location in order to find their way back later on. Previous studies have demonstrated that the insects flexibly modify their learning flights depending on the characteristics of the visual scene in which they perform them. However, it is unknown whether they adapt their visual learning to the type of the location they depart. We recorded the learning flights of bumblebee leaving their nest or an artificial flower with identical visual surroundings. The nest exit and the flower were located at the top of two tables covered with white gravel. A purple ring marked the nest exit and the flower and three large black cylinders were placed north of each goal. Our results show that bumblebees perform longer learning flights, over a larger area and scan a larger proportion of the visual scene at the nest than at the flower. These marked differences suggest different investments in learning, with more effort made to memorise the location of the unique and often inconspicuous nest-hole than the numerous locations of conspicuous flowers.

Robert T, Frasnelli E, Collett T, Hempel de Ibarra N

Presentation 4

Talas, Laszlo, University of Bristol

The “Camouflage Machine”: Optimising patterns for camouflage and visibility

To remain unseen, an effective strategy is to maximise crypsis: matching both the textures and colours of the background. Camouflage is important in both natural and human-made environments, such as in a prey-predator arms race or concealing urban infrastructure. While camouflage focuses on reducing visibility and, for animals is obviously advantageous in enhancing survival, highly visible warning or sexual signals can also provide a significant evolutionary advantage. Furthermore, much modern infrastructure is economically important, but is often not aesthetically pleasing and creates visual clutter. Although highlighting the problem is straightforward, finding a solution for any given environment is not trivial given the vast range of possible colours and textures.

We present a framework, dubbed the ‘Camouflage Machine’ that provides an efficient method to find optimal colour and texture combinations for concealment or conspicuity in a given

environment. A texture-space with more than 2000 naturalistic textures was produced using Gray-Scott reaction-diffusion equations. We presented human participants with patterns in monochromatic, dichromatic and trichromatic contexts, using three-layer experimental stimuli (foreground-target-background) created using chroma key replacement, and measured their reaction time to detect a single target. Genetic algorithms were used in order to sample efficiently the most (in)conspicuous colours and textures based on detection times for previous trials. Deep neural networks were then built to provide interpolation of reaction times across the full texture and colour gamut. Patterns identified for best camouflage were validated using existing military camouflage and were found to be significantly more effective.

Talas, L; Fennell, J; Baddeley, R; Cuthill, I; Scott-Samuel, N

Session 2 – Chair, Professor Darren Cosker, University of Bath

Presentation 5

Saquil, Yassir, University of Bath

Generative models for semantic data exploration

In the modern world we have a huge amount of non-structural data on the web. Performing a meaningful representation of those data is one of the challenging tasks in machine learning. One common way of exploring those data is to enable the user to search by textual tags, the results are in the form of a list ordered by a specific criteria, such as popularity or a relevant index. However, these measures are defined uniformly for all the users, and do not take into consideration the user preferences.

These issues, unveil the importance of embedding the user experience while developing a data browsing tool. In this paper, we propose a new technique to explore imagery data according to their subjective preferences at a high semantic level. More formally, it consists of asking the user to interactively define useful criteria and rules implicitly from some samples, then those rules will be propagated to label the remaining data examples. At this level the images can be ordered in a discrete slider according to the user preference.

Furthermore, in order to enhance the browsing experience, we use generative models to synthesise new images conditioned with the implicitly inferred criteria and hence being able to provide the user with a continuous slider. The potential domain of application is broad, integrating this method of organising data in existing commercial recommendation systems, such as newsletters, shopping and fashion websites, will allow them to provide more personalised content to the end user.

Yassir Saquil

Souri, Y., Noury, E. and Adeli, E., 2016, November. Deep relative attributes. In Asian Conference on Computer Vision (pp. 118-133). Springer, Cham.

Zhu, J.Y., Krähenbühl, P., Shechtman, E. and Efros, A.A., 2016, October. Generative visual manipulation on the natural image manifold. In European Conference on Computer Vision (pp. 597-613). Springer, Cham.

Goodfellow, I., Pouget-Abadie, J., Mirza, M., Xu, B., Warde-Farley, D., Ozair, S., Courville, A. and Bengio, Y., 2014. Generative adversarial nets. In Advances in neural information processing systems (pp. 2672-2680).

Presentation 6
Gale, Ella, University of Bristol

Characterising and manipulating the learned representation of visual data in deep-neural networks trained to classify images

In the last 10 years, deep- and convolutional artificial Neural Networks (NNs) have been able to classify images to a decent degree of accuracy. AlexNet (Krizhevsky, 2012) has even shown gabor-like filters at the lower levels, similar to models of the mammalian visual cortex. However, concerns were raised when trained NNs were successfully ‘hacked’ by the addition of high-frequency data (which humans ignored) to incorrectly label photographs (Goodfellow 2012). Small sticker patches (Brown, 2017) and minor perturbations (Elsayed, 2018) could cause mislabelling, and repetitive abstract patterns were labelled as objects with high confidence (Nguyen, 2015). Understanding how visual data is processed and internally represented within a NN is thus crucial to understanding how to build artificial vision systems.

Our previous research has elucidated how binary data is internally represented within a NN and how aspects of the input data and NN training method alter these representations. Here we train the same NN set-up under several different modifications (e.g. different regularisers) to classify large image datasets. Using generative adversarial networks (GANs) to synthesize highly activating images (Nguyen 2016) and manipulating the input images, we can learn which features each neuron is sensitive to. These methods allow us to probe some of the ‘hidden’ concepts the NN learns. We have found sensitivity to colour and shape at lower levels than category sensitivity, and links between both related and confusable categories at these levels. The inability of NNs to recognise sketches of objects suggest NNs weigh texture higher than shape in classification.

Gale, E, Martin N., Bowers, J.

Brown, T.B., Mané, D., Roy, A., Abadi, M. and Gilmer, J., (2017). Adversarial Patch. ArXiv e-prints (Dec. 2017). arXiv preprint cs.CV/1712.09665.

Elsayed, G.F., Shankar, S., Cheung, B., Papernot, N., Kurakin, A., Goodfellow, I. and Sohl-Dickstein, J., (2018). Adversarial Examples that Fool both Human and Computer Vision. arXiv preprint arXiv:1802.08195.

Presentation 7
Kangin, Dimitry, University of Exeter

Reinforcement learning for vision based control

In this presentation, we address the problem of continuous vision-based control using a combination of supervised and reinforcement learning.

Reinforcement learning methods have achieved impressive results on a range of tasks; however, for large input and/or action spaces, such as complex visual inputs, they take many iterations before achieving convergence. In this talk, we briefly review the state-of-the-art applications of reinforcement learning for machine vision applications and discuss our research in improvement of sample efficiency of reinforcement learning as well as our approach to regularise an actor-critic based reinforcement learning method with supervised data. We show that the method (Kangin and Pugeault (2018)) allows us to significantly leverage the performance on complex visual driving tasks, and we show how it could be used for a wide range of practical applications. We

demonstrate the efficiency of the proposed methods in the TORCS / SpeedDreams driving simulator, where we use them for producing steering control signals based on visual input, as well as show validity of the method on the well-known MuJoCo robotics scenarios.

Kangin, D.; Pugeault, N

Kangin, D. and Pugeault, N., 2018. Continuous Control with a Combination of Supervised and Reinforcement Learning. International Joint Conference on Neural Networks, Brazil.

Presentation 8

Masullo, Alessandro, University of Bristol

CaloriNet: From silhouette to calorie estimation in private environments

We propose a novel deep fusion architecture, CaloriNet, for the online estimation of energy expenditure for free living monitoring in private environments, where RGB data is discarded and replaced by silhouettes. Our fused convolutional neural network architecture is trainable end-to-end, to estimate calorie expenditure, using temporal foreground silhouettes alongside accelerometer data. The network is trained and cross-validated on a publicly available dataset, SPHERE_RGBD + Inertial calorie, from Tao, L. et al., 2018. Results show state-of-the-art minimum error on the estimation of energy expenditure (calories per minute), outperforming alternative, standard and single-modal techniques.

Masullo, A; Burghardt, T; Damen, D; Hannuna, S; Ponce-López, V; Mirmehdi, M

Tao, L. et al., 2018. Energy expenditure estimation using visual and inertial sensors. IET Computer Vision, 12(1), pp.36–47.

Session 3: Chair, Dr Natalie Hempel de Ibarra, University of Exeter

Presentation 9

Zappala, Stefano, Cardiff University

Investigation of the mechanics underlying brain shift: an image-based approach for the measurement of the in-vivo deformation of the brain

Introduction

Deep brain stimulation is the most common long-term treatment of movement disorders, such as Parkinson's disease and essential tremor. The procedure consists in the positioning of electrodes deep inside the brain and necessitates for accurate pre-operative planning. However, the brain sags against the skull under the effect of gravity depending on the head orientation (brain shift), causing its conformation to differ from the one imaged pre-operatively. A thorough in-vivo evaluation of such deformation on a healthy population is needed, since brain shift has been mainly studied in case of invasive neurosurgery.

Methods

At present, a pilot study has been completed, which consisted in the measurement of the brain shift due to prone to supine change of positioning. Four consecutive structural magnetic resonance (MR) images were acquired for each of eight healthy participants (age range 22-30 years, average 25 years) from a 7T MR scanner. Elastic registration allowed the estimation of the

displacement of each voxels in the brain area. The time evolution of such deformation was evaluated, as well as the local patterns of deformation in terms of volume change and strain distribution.

Results and Discussion

The proposed protocol successfully quantified brain shift, which resulted around 3.5 mm in magnitude, stabilised before ten minutes. Such deformation appeared to be a relatively fast process in comparison with the results in the literature. The volumetric analysis showed numerous local variations in the strain distribution, proving a correlation between brain shift and the microstructure of the tissue.

Zappala, S, Bennion, N, Harrison, R, Wu, J, Jones, D, Evans, S, Marshall, D

Miga, M. I. (2016). Computational Modeling for Enhancing Soft Tissue Image Guided Surgery: An Application in Neurosurgery. *Annals of Biomedical Engineering*. <https://doi.org/10.1007/s10439-015-1433-1>

Schnaudigel, S., Preul, C., Ugur, T., Mentzel, H. J., Witte, O. W., Tittgemeyer, M., & Hagemann, G. (2010). Positional brain deformation visualized with magnetic resonance morphometry. *Neurosurgery*, 66(2), 376–384. <https://doi.org/10.1227/01.NEU.0000363704.74450.B4>

Ou, Y., Sotiras, A., Paragios, N., & Davatzikos, C. (2011). DRAMMS: Deformable registration via attribute matching and mutual-saliency weighting. *Medical Image Analysis*, 15(4), 622–639. <https://doi.org/10.1016/j.media.2010.07.002>

Presentation 10

Hunt, Edmund, University of Bristol

Asymmetric eyes and behavioural lateralization

Asymmetries in behaviour are thought commonly to originate in asymmetries in the body, typically the nervous system [1]. However, relatively little work [2] has been done to correlate behaviour with readily observable morphological asymmetries in the visual system, a crucial sensory modality for many organisms.

Workers of the house-hunting ant *Temnothorax albipennis* rely on visual edge following and landmark recognition to navigate their rocky environment, and they also exhibit a leftward turning bias when exploring unknown nest sites [3]. We used electron microscopy to count the number of ommatidia composing the compound eyes of worker ants, to make an approximate assessment of their sampling resolution and to establish whether there is an asymmetry in the number of ommatidia between left and right, which might provide an observable, mechanistic explanation for the turning bias. We hypothesise that even small asymmetries in relative visual acuity between left and right eyes could be magnified by developmental experience into a symmetry-breaking turning preference that results in the inferior eye pointing toward the wall.

Fifty-six workers were examined: 45% had more ommatidia in the right eye, 36% more in the left, and 20% an equal number. A tentative connection between relative ommatidia count for each eye and turning behaviour was identified, with a stronger assessment of behavioural lateralization before imaging and a larger sample suggested for further work [4]. We hope this points the way to further studies of insect compound eye asymmetry and behavioural lateralization: ommatidia asymmetries have previously been indicated in honeybees [5] and various fly species [6].

Hunt, ER; Dornan, C; Sendova-Franks, AB; Franks, NR

- [1] Frasnelli, E., Vallortigara, G. & Rogers, L. J. Left-right asymmetries of behaviour and nervous system in invertebrates. *Neurosci. & Biobehav. Rev.* 36, 1273-1291, doi:10.1016/j.neubiorev.2012.02.006 (2012).
- [2] Coimbra, J. P., Collin, S. P. & Hart, N. S. Topographic specializations in the retinal ganglion cell layer correlate with lateralized visual behavior, ecology, and evolution in cockatoos. *J. Comp. Neurol.* 522, 3363-3385, <https://doi.org/10.1002/cne.23637> (2014).
- [3] Hunt, E. R. et al. Ants show a leftward turning bias when exploring unknown nest sites. *Biol. Lett.* 10, 20140945, <https://doi.org/10.1098/rsbl.2014.0945> (2014).
- [4] Hunt, E. R. et al. Asymmetric ommatidia count and behavioural lateralization in the ant *Temnothorax albipennis*. *Sci. Rep.* 8, 5825, <https://doi.org/10.1038/s41598-018-23652-4> (2018).
- [5] Letzkus, P., Boeddeker, N., Wood, J. T., Zhang, S. W. & Srinivasan, M. V. Lateralization of visual learning in the honeybee. *Biol. Lett.* 4, 16-19, <https://doi.org/10.1098/rsbl.2007.0466> (2008).
- [6] Seidl, R. & Kaiser, W. Visual field size, binocular domain and the ommatidial array of the compound eyes in worker honey bees. *J. Comp. Physiol.* 143, 17-26, <https://doi.org/10.1007/bf00606065> (1981).

Presentation 11

Lévêque, Lucie, Cardiff University

An eye-tracking study with mammograms

Mammography screening has been widely used in the last decades to detect early breast lesions. The use of medical images for screening is highly beneficial for patients as it increases the likelihood of cancer being treated [1]. However, errors can occur due to the limitations of human perception. Understanding how radiologists perceive mammograms is thus critical to optimise image interpretation.

We present a new eye-tracking study where the eye movements of two expert radiologists were recording while assessing 194 multi-lateral oblique view mammograms. Their eye movements were recorded using a SMI eye-tracker.

Gaze information was extracted directly from the raw eye-tracking data. Fixations are rigorously defined in [2], with a minimum duration threshold of 100 ms. The observed difference between the mean duration of fixations recorded for each radiologist was statistically analysed using hypothesis testing; results show no significant difference. This can be explained by the fact that both observers have substantial experience in mammography.

Eye-tracking data can be graphically rendered to provide evidence of human visual behaviour; a saliency map is derived from recorded fixations. The salient regions designate where human observers focus their gaze with a higher frequency. An evaluation was carried out with three state-of-the-art saliency models; they do not precisely match with the ground truth.

Lévêque, L; Liu, H.

Lévêque, L; Liu, H.

Presentation 12
Blything, Ryan, University of Bristol
Translating invariance in vision

A major challenge for the visual system is to recognise objects independent of retinal position. To assess the extent of visual translation invariance, Bowers, Vankov, and Ludwig (2016) trained participants to identify six novel images in fixed retinal locations and tested their ability to identify the images at different locations. Participants identified the objects following a shift of 13 degrees, challenging theories that assume much less invariance.

One limitation with this work, however, is that participants only learned 6 novel objects, and this raises the possibility that each object was identified on the basis of a few features, in which case, the invariance may not have extended to the objects themselves. We report a series of experiments in which participants are trained with over 20 novel images using a range of different object types (e.g., 3D objects). Under these conditions it is more difficult to identify an image based on isolated features.

Images are trained at fixation and participants are asked to identify the objects at a range of retinal eccentricities (i.e., untrained retinal locations), using eye-tracking technology to ensure the images are presented at intended retinal locations. Participants were able to identify novel objects at untrained retinal locations at a rate significantly above chance, challenging theories that claim experience is necessary at each retinal location to achieve invariance.

Blything, R. 1, Ludwig, C. 1, Vankov, I. 2, and Bowers, J. 1

Bowers, J.S., Vankov, I., & Ludwig, C.J.H. (2016). The visual system supports online translation invariance for object identification. *Psychon Bull Rev*, 23, 432-438.

Posters

Poster 1

Bok, Michael, University of Bristol

Looking with gills: The diverse, distributed visual systems in fan worms

Fan worms (Annelida: Sabellidae) possess a spectacular array of distributed compound eyes on their titular feeding tentacles. These eyes govern a startle response that allows the worms to rapidly withdraw into their tubes when threatened by looming predators. While this behaviour is simple and well conserved within the family, the arrangement of their tentacular eyes is quite diverse among species, with some utilizing a single pair of large consolidated compound eyes on two tentacles while others have hundreds of smaller compound eyes or ocelli scattered all over the outsides of every tentacle [1-3]. How do these two different strategies manage the same behaviour, and what are their relative benefits or drawbacks? Here we present molecular and anatomical data that casts light onto the evolution and development of these photoreceptors as well as physiological and behavioural data examining their function and wiring into the brain. We show that these eyes make use of unusual photoreceptors and neural pathways not previously implicated in visual systems, lending credence to the idea that they represent an independent evolutionary elaboration unique to fan worms.

Bok, M

1. Bok, M.J., Capa, M. & Nilsson, D.-E., 2016. Here, There and Everywhere: The Radiolar Eyes of Fan Worms (Annelida, Sabellidae). *Integrative and Comparative Biology*, 56, 784-795.
2. Bok, M.J., Porter, M.L., HOVE, Ten, H.A., et al., 2017. Radiolar Eyes of Serpulid Worms (Annelida, Serpulidae): Structures, Function, and Phototransduction. *The Biological Bulletin*, 233, 39-57.
3. Bok, M.J., Porter, M.L. & Nilsson, D.-E., 2017. Phototransduction in fan worm radiolar eyes. *Current Biology*, 27, pp.R698-R699.

Poster 2

Brodict, Emelie, University of Bristol

Crustacean vision: adaptable eyes for extreme changes in light

Compound eye designs of arthropods are highly specialized to suit the lifestyle and habitat of that animal and there is great variation in eye size, shape, internal structure, photopigment and sensitivity between taxa. Fiddler crabs, *Uca tangeri*, are subject to extreme changes in ambient light conditions in their tropical mudflat habitats. They must adjust their eye sensitivity to maximize the available light when foraging at night, whilst also protecting them from photobleaching in the intensely bright conditions of daytime. The mechanisms in which fiddler crabs achieve this and the how rapidly or regionally the eyes adjust to extreme changes in light is currently unknown.

In this investigation, transmission electron microscopy (TEM) and synchrotron X-ray microtomography allowed fine changes in eye anatomy involved with mechanisms for visual adaptation to be observed in the fiddler crab. In darkness and especially at night, crabs were found to grow the surface area of the photosensitive rhabdom, becoming much wider in comparison to the narrow rhabdom of the light-adapted state.

Subsequent behavioural experiments showed that the sensitivity of the visual system is enhanced in the dark-adapted eye and there appears to be a strong circadian influence on the process, in accordance with our anatomical findings. Results also suggest that changes in adaptation state in response to extreme light level alterations occur over a relatively slow time course (minutes to hours). Rapid responses such as “pupil” changes via screening pigment migrations within the eyes have not been observed in this species.

Brodrick, E.A., Roberts, N. & How, M.J

King & Cronin, 1994. *Journal of Comparative Physiology A*, 175, 331-342.

Miller & Cawthon, 1974. *Investigative Ophthalmology & Visual Science* 13, 401-405.

Rosenburg & Langer, 2001. *Journal of Crustacean Biology*, 21, 345-35

Poster 3

Burtan, Daria, University of Bristol

Image aesthetics, not basic image statistics, affect human gait parameters

Exposure to urban environments is thought to pose higher demands on visual attention and thus cognitive load than exposure to nature; an effect even observed when looking at photographs (Berman et al., 2008). In line with overwhelming evidence that gait slows with increasing cognitive load (for review see Amboni et al., 2013), Joyce and Leonards (2017) found that people walk more slowly with smaller steps toward images of urban scenes as compared to nature scenes. Yet, it remains unclear what exactly it is in urban images that produces this effect: basic image statistics (e.g. colour, spatial frequency distributions), cognitive associations with image content, or image likeability. Here, we tested the impact of different amounts of “greenery” in an image on gait, using images synthesized from a reflectance and formation model by Griffin and Mylonas (2018) with colour histograms that match natural images. Twenty-two participants repeatedly walked down the laboratory toward images projected to the back wall, rating each image for its likeability. Images were presented in random order (20 images each for five levels of greenery; 5 medium-grey images), one image per walk. Gait parameters were measured with 3D-motion capture. Overall, the amount of greenery in an image did not affect stride length or timing. However, an increased subjective visual liking score was predictive of increased average step length ($r=.290$, $p\leq 0.005$) and velocity ($r=.204$, $p\leq 0.05$). These data suggest that, rather than image statistics, it might be image aesthetics that determine the cognitive load of urban and nature images, and thus gait.

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Poster 4

Clark, Rosie, University of Bristol

What can eye-tracking tell you about a child's pursuit eye movements than an orthoptist can't? Pilot study

Introduction

In our clinic for children with neurodevelopmental disorders, many have abnormal smooth pursuit eye movements (SPEM). We wanted to investigate the feasibility and utility of objective eye tracking (OET) for these children.

Objective

To compare an orthoptist using a 5-point grading score, with OET recordings.

Methods

12 children aged 5-17 with special educational needs (SEN) were recruited. Horizontal and vertical SPEM were examined by an orthoptist and with OET, from which we derived "positional accuracy" (mean distance between eye and target) and numbers of saccadic intrusions. Within-child comparisons of saccadic intrusions in horizontal and vertical SPEMs were made using Log Linear analysis.

Results

The orthoptist graded SPEM in all 12 children whilst OET data were obtained in only 4. Three of the 4 had normal grading scores (4-5) and their positional accuracies were all ± 5 degrees. One child had abnormal grading scores (2 – 3.5) and positional accuracy of ± 10 degrees. Clinical grading suggested no differences between horizontal and vertical SPEMs. The OET data revealed more intrusive saccades for vertical than horizontal SPEMs (2 children, $p=0.001$ and $p=0.018$ respectively) and vice versa for 1 child ($p=0.008$), with corresponding reduced positional accuracy.

Conclusions

Adapted calibration protocols are needed to allow more children to be tested. Clinical grading of abnormal SPEM in 1 child was supported by OET data. The OET revealed clinically undetected differences between horizontal and vertical SPEM in 3 children. These findings may be useful diagnostically or in rehabilitation for children with SEN and further research is needed.

Clark, R. (1), Williams, C. (1), Gilchrist, I.D. (2)

Poster 5

Costello, Leah, University of Bristol

The use of 'false holes' in camouflage

In some Lepidoptera, continuous wing surfaces have markings that, to the human eye, appear to resemble 'holes'. These markings disrupt the wing surface continuity, possibly through creation of false depth, preventing the wing from being appreciated in its entirety. False hole markings are often associated with leaf mimicry, resembling decaying or skeletonised leaves.

Surface disruption is an aspect of disruptive patterning that has received far less attention, as disruptive theory focuses on markings found at the body periphery which act to impede edge detection mechanism. However, internal markings may also function to break up or disrupt a

continuous surface into apparently separate objects and shapes, hindering or preventing recognition; Cott (1940) termed this 'Surface Discontinuity'.

I have found no previous empirical evidence to support or refute the proposed survival benefit of these markings; hence I present the first empirical evidence that false holes reduce avian predation in Lepidoptera. I explore whether these markings confer protective benefit from avian predation, and whether this benefit is due to hole-resemblance, or whether any high contrast surface markings are effective. Survival analysis of avian predation experiments of artificial butterfly-like prey revealed that there was a highly significant effect of treatment.

I conclude that holes in wings of artificial butterfly-like prey reduce predation, as do dark patches the same size and shape as holes by up to the same degree. Equivalent high contrast light patches decreased survival, so the benefit of dark patches is not through lateral inhibition or contour capture.

Costello, L.

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Presentation 6

Crellin, Eleanor, University of Bath

Can motion graphs be used for quadrupedal animation?

Example-based motion synthesis methods such as motion graphs have largely been restricted to use with bipeds, as quadrupedal motion is hard to acquire. However, these methods are popular ways of creating animation in industry and academia. The alternative is typically use of physical-based methods, for example Coros, et al. (2011), which have complex implementations and usually lack naturalness and generalisability.

The purpose of this research is therefore to determine if motion graphs will work with quadrupedal motion data. Given that, when using motion graphs, animation is driven by the path of a root, the physiological difference between bipeds and quadrupeds is a significant factor. Traditionally, a human's root is at the 'hips', but the correct root is less clear for quadrupeds, who can rotate through their 'shoulders' or 'hips'. We sought to ascertain whether a root-driven, procedural method would result in visually plausible animation, or whether conflicts between the two root joints would result in motion artifacts.

To test this, we implemented the method of Kovar, et al. (2002) to generate motion in Unreal Engine (Epic Games, 2018), but trained it with canine motion instead of human motion. We generated multiple animations using the motion graph and studied both the presence of artifacts and similarity to the training data. The results are generally promising. Artifacts due to constraining the animal's hips are not present, and the motion is observably similar in shape to the original and looks plausible to a human observer.

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Presentation 7

Di Martino, Alessandro, University of Bath

Gaussian process deep belief networks: a smooth generative model of shape with uncertainty propagation

The shape of an object is an important characteristic for many vision problems such as segmentation, detection and tracking. Being independent of appearance, it is possible to generalise to a large range of objects from only small amounts of data. However, shapes represented as silhouette images are challenging to model due to complicated likelihood functions leading to intractable posteriors. In our work we present a generative model of shapes which provides a low dimensional latent encoding which importantly resides on a smooth manifold with respect to the silhouette images. The proposed model propagates uncertainty in a principled manner allowing it to learn from small amounts of data and providing predictions with associated uncertainty. We provide experiments that show how our proposed model provides results at par with the state-of-the-art while simultaneously providing a representation that resides on a low-dimensional interpretable manifold.

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Presentation 8

Dyke, Roberto, Cardiff University

Non-rigid registration under anisotropic deformations

Non-rigid registration of deformed 3D shapes is a challenging and fundamental task in geometric processing, which aims to non-rigidly deform a source shape into alignment with a target shape. Current state-of-the-art methods assume deformations to be near-isometric. This assumption does not reflect real world conditions, for example in large scale deformation, where small anisotropic deformations (e.g. stretches) are common. We propose two significant changes to a typical registration pipeline to address such challenging deformations. First, we propose a method to estimate anisotropic non-isometric deformations and incorporate this into an iterative non-rigid registration pipeline. Second, we compute additional correspondences in non-isometrically deforming regions using reliable correspondences as landmarks and prune inconsistent correspondences. We observe superior registration results when compared to the current state-of-the-art.

Dyke, Roberto; Lai, Yu-Kun; Rosin, Paul

Presentation 9
Fan, Liang, Cardiff University

An improved Siamese network for face sketch recognition

Face sketch recognition refers to matching the face photo from a huge dataset according to a given face sketch image. Different from human, computers cannot compare the similar images between different modalities directly because visual information which can be perceived from face sketch and photo is different. The main challenge is to reduce the modality gap between photo and sketch image. The early methods of face sketch recognition are to synthesise a pseudo photo/sketch using Karhunen–Loève Transform to convert different modalities of images into the same modality (Tang and Wang, 2004). Another method which projects the photo and corresponding sketch into a common space bypasses generating a pseudo image and obtains more than 90% recognition accuracy (Sharma and Jacobs, 2011). The third type of methods is feature-based method that extracts effective features to measure the similarity between the photo and corresponding sketch using a specific feature descriptor (Klare and Jain, 2013). Compared with the above-mentioned three methods, deep learning method extracts more effective features and textures. However, a small amount of dataset causes overfitting to affect the recognition rate. Furthermore, the existed loss functions cannot separate different people effectively when the face photos and sketches are projected to the same feature space. In order to solve the two problems, we used siamese CNN architecture (Chopra et al., 2005) to encode the training images on a common space. Then margin-based contrastive loss function is used to separate the encoded information on chi-square distance.

Fan, Liang

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Poster 10

Fernandez Alonso, Mariana, University of Bristol

A study of subjective video quality at various spatial resolutions

The video parameter space is being extended to satisfy the desire by consumers for more immersive and high quality video experiences [1]. The unavoidable consequence of increased spatial resolution is higher data rates - a key problem for content providers. Before spatial adaptive video formats become commonplace, further research is required to characterise the relationship between visual quality and spatial resolution, such that robust quality metrics can be tested/developed. In this paper we present the BVI-SR video database, which contains 24 unique video sequences at a range of spatial resolutions up to UHD-1 (3840p). These sequences were used as the basis for a large-scale subjective experiment exploring the relationship between visual quality and spatial resolution when using three distinct spatial adaptation filters - including a state-of-the-art CNN-based super-resolution method (VDSR) [2]. We then test a selection of quality

metrics on the subsequent ground truth to determine their suitability for resolution adaptation. The results demonstrate that image quality metrics can successfully model visual quality across the range of test conditions, and therefore could be utilised within future adaptive formats algorithms. The quality metric VIF [3] was shown to offer the best performance. Furthermore, while spatial resolution was shown to have a significant impact on mean opinion scores (MOS), no significant reduction in visual quality between UHD-1 and HD resolutions for the super-resolution method was reported.

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Poster 11

Galloway, Jim, University of Exeter

The role of diet vs vision in chameleon prawn colour change

Given that camouflage is generally considered an adaptation to avoid visual detection, it is logical to assume colour change for camouflage is informed by visual stimuli. While this has been tested in the rapid colour change in cephalopods (and some other species) it still needs to be investigated in other taxa [1]. Hippolyte varians is a decapod crustacean with several discrete colour variants. Coloured forms associated with algal grazing substrates are plastic, changing over a period of days when introduced to algal substrates of a different colour [2]. Given the relationship between H. varians and its natural substrates, diet could be influencing colour change rather than vision (shown to be the case in other taxa [3]). This study compared the ability of 2 colour variants of H. varians to change colour on edible (macroalgal) and inedible (polypropylene) substrates, over a period of 30 days. Our results indicate that H. varians is capable of changing colour to improve substrate matching on both mismatching algal and synthetic substrates, based on models of relevant predator vision. However, due to limitations on substrate colour and likely differences in animal vision, we were unable to test for changes of one colour variant on inedible substrates.

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Poster 12

Harris, David, University of Exeter

Examining the role of visual attention in multiple object tracking expertise

During most daily activities attention is sequentially allocated, seeking out the most relevant information to execute the current task (Land, 2006). Conversely, dynamic tasks such as navigating a busy street or team sports require monitoring of multiple simultaneously moving objects. The multiple object tracking (MOT) paradigm (Pylyshyn and Storm, 1988), where participants track multiple moving targets amongst visually similar distractors, has been used to study this ability. While gaze strategy predicts object tracking performance (Fehd and Seiffert, 2010; Zelinsky and Neider, 2008), it is unclear whether changes in visual attention are responsible for the development of tracking expertise. Consequently, we aimed to investigate whether expertise in an MOT task is dependent on eye movement strategy during trials, by comparing the performance and eye movements of team sport athletes (experts with real world object tracking) with non-team sport athletes. It was found that directing gaze to a central location (the centroid), rather than sequential switching between targets, was beneficial for performance. Team sport athletes displayed improved object tracking ability relative to non-team sport athletes, but this was not as a result of increased gaze toward the centroid. These findings suggest that while visual attention plays a role in object tracking, the development of expertise may be dependent on other abilities.

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Poster 13

Hartley, Thomas, Cardiff University

Self-pruning CNNs using predicted filter salience

It has been shown that convolution neural networks are often over parametrised, leading to inefficiencies at runtime [1]. Subsequently a number of pruning techniques have been developed to remove unnecessary parameters [2,3]. These include both traditional pruning techniques where the network is iteratively analysed and pruned, to dynamic networks where the network is able to adapt to a given input. We propose a dynamically pruned network where we aim to predict the relevance of each convolution layers filters in real time before the input gets to that layer. As with other dynamic methods, this is performed using a decision-making module (in our case saliency models). The novelty in our method is the introduction of a self-pruning element. This results in our saliency models pruning themselves as filters are dynamically removed from the base network. By pruning both the network and the auxiliary networks used in the decision-making process, we are able to increase the efficiency of the network allowing the computational resources required to be decreased. This allows networks to be deployed on platforms where resources may be shared or limited such as smartphones or embedded systems. We obtain

promising results using our technique. We are able to reduce the parameters in our network compared to the original network, whilst simultaneously pruning the saliency models.

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Poster 14

He, Sen, University of Exeter

What catches the eye? Visualizing and understanding deep saliency models

Deep convolutional neural networks have demonstrated high performances for fixation prediction in recent years. How they achieve this, however, is less explored and they remain to be black box models. Here, we attempt to shed light on the internal structure of deep saliency models and study what features they extract for fixation prediction. Specifically, we use a simple yet powerful architecture, consisting of only one CNN and a single resolution input, combined with a new loss function for pixel-wise fixation prediction during free viewing of natural scenes. We show that our simple method is on par or better than state-of-the-art complicated saliency models. Furthermore, we propose a method, related to saliency model evaluation metrics, to visualize deep models for fixation prediction. Our method reveals the inner representations of deep models for fixation prediction and provides evidence that saliency, as experienced by humans, is likely to involve high-level semantic knowledge in addition to low-level perceptual cues.

Our results can be useful to measure the gap between current saliency models and the human inter-observer model and to build new models to close this gap.

He, S

He, Sen, et al. "What Catches the Eye? Visualizing and Understanding Deep Saliency Models." arXiv preprint arXiv:1803.05753 (2018).

Poster 15

Katsenou, Angeliki, University of Bristol

Perceptually-aligned frame rate selection using spatio-temporal features

Apart from the semantics of the content, the other key factors of visual experiences that influence immersion are the spatial resolution, the dynamic range and the frame rate of the video. While significant work has been reported on dynamic range extension, less has been reported on the influence of frame rate, which is the focus of this work. Although there has been an increase in the availability of 4K video at 60 frames per second, the demand of higher resolutions up to 8K adds pressure to further increase frame rate [1, 2]. High frame rates are important as they improve perceptual video quality and reduce the visibility of motion artefacts (e.g. motion blur, aliasing) [3– 6]. However, increasing the frame rate, significantly raises bandwidth demands and makes the task of video delivery even more challenging for the service providers. Taking into consideration

this challenge on one hand and the content dependent nature of perceived video quality at different frame rates on the other hand, a content-driven perceptually aware frame rate selection mechanism is required. This work presents a relatively low complexity frame rate selection process that is based on a supervised machine learning technique that uses only a few spatio-temporal features extracted from the original HFR. Compared to the recent literature, the proposed method has the advantage of using only the original HFR resulting in reduced complexity. This approach offers the potential to minimise acquisition bit rates and hence storage or transmission requirements prior to compression.

Katsenou, Angeliki V., Ma, Di, Bull, David R.

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Poster 16

Latham, Jack, Cardiff University

Localisation and assessment of Doppler ultrasound cardia output scans

Doppler ultrasound (US) can be used to measure a person's cardiac output quickly and non-invasively; use of the technology is however not common practice. This is largely due to a slow learning curve in using this method (Dey, 2005; Huang and Critchley, 2013a). We are developing a new method and accompanying software to try and reduce this learning curve, and to give confidence to users of the technology. The software aids users in locating an optimal signal, and in assessing acquired signals by providing signal quality feedback. Location feedback is provided by predicting the current location of the US transducer with respect to the ideal location, this is achieved using a convolution neural network (CNN).

The input to the CNN is an image displaying the spectral content of the Doppler signal for one cardiac cycle. To generate these images, the Doppler signal must first be converted into a spectrogram, from which the maximum velocity envelope of the blood can be calculated. The method to calculate this envelope need to be robust – various documented methods were tested (D'Alessio, 1985; Kathpalia et al., 2016); the current method is a combination and adaption of these. The resulting envelope is used to automatically segment the Doppler signal into cardiac cycles; from which individual images can be generated and used with the neural network. The image can also be used to assess the quality of the scan, for example by computing a 'scan score' based on documented criterion (Dey, 2005; Huang and Critchley, 2013b).

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Poster 17

Lim, Anna, University of Bristol

Iridescence as a deceptive anti-predator strategy

Iridescence is a form of structural colouration found in many animal taxa, where nanostructures alter the wavelengths of light reflected depending on viewing angle. This shifting colour can be used as a warning or sexual signal, but this variability may also have the potential to deceive and confuse predators (Endler, 1988). We hypothesise that iridescence may function as form of deceptive camouflage by producing a fluctuating signal which could slow visual object recognition. This was tested using domestic chicks (*Gallus gallus domesticus*) as visual predators and beetles as prey. We trained chicks to associate iridescent and non-iridescent beetle shells with a reward, and then tested how fast they were able to detect each prey item against an artificial ivy background. Iridescent wing cases from Jewel Beetles (*Sternocera aequisignata*) were used, as well as resin targets in 5 control colours. These search tasks were repeated under normal and dappled light conditions, which were created using mirror balls to replicate forest floor light.

Our preliminary results show that the chicks found non-iridescent targets faster than iridescent and green targets. Green targets were expected to have high difficulty as they closely matched the background in colour, however the iridescent targets' high difficulty supports our hypothesis that iridescence can function as a form of camouflage. We conclude that iridescence provides protection against predation by birds, and this may explain the widespread occurrence of iridescence in nature.

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Poster 18

Ma, Di, University of Bristol

Developing a parameterisable synthetic video dataset for analysis and compression purposes

With the development of modern communications and enhanced demands for immersive video content from users, there is a large amount of video data that needs to be compressed while preserving its perceived quality [1]-[3]. Based on previous studies on analysis and classification of video content for compression purposes, video textures are classified into three types - Static and Dynamic textures (Continuous and Discrete) [4]. Different types of textures have different coding performance, which makes it essential to have a thorough understanding of the inter-relations of these factors. This is a challenge mainly because of the lack of a large dataset that contains many different variations (different camera motion, frame rate, temporal and spatial patterns, etc.) of static and dynamic homogeneous textures. In addition, due to the infinite number of potential combinations of parameters related to video content and acquisition, it is impractical to capture multiple variations of videos to study the parameter interplay. Therefore, the generation of a parameterisable synthetic video dataset is required. This work is focused on generating a synthetic dataset with the aim to study and analyse the compression performance. This synthetic dataset is developed using a controlled graphics environment, Unreal Engine [5]. We start this work by generating a set of homogeneous dynamic and static video textures, HomTex [4].

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Poster 19

Matchette, Samuel, University of Bristol

Concealment in a dynamic world: dappled light and caustics mask movement

The environment plays a significant role in shaping the visibility of signalling both to and from an organism. For example, against a static background movement is highly conspicuous, which favours staying still to optimise camouflage. However, backgrounds can also be highly dynamic, such as areas with wind-blown foliage or frequent changes in illumination. We propose that these dynamic features act as visual noise which could serve to mask otherwise conspicuous movement. We simulated two forms of illumination change - water caustics and dappled light - representing dynamic aquatic and terrestrial environments respectively. When asked to capture moving prey items within the simulated scenes, human participants were significantly slower and more error-prone when viewing scenes with dynamic illumination. This effect was near identical for both the aquatic and terrestrial environment. In the latter, prey item movement was also found to be

masked most often when the pathway taken involved movement across the dynamic dappled areas of the scene. In particular, this could allow moving prey to reduce their signal-to-noise ratio by behaviourally favouring the relative safety of environments containing dynamic features such as these.

Matchette, S; Cuthill, I; Scott-Samuel, N

Poster 20

Meah, Rochelle, University of Bristol

Evolutionary responses to anthropogenic light – phenotypic shifts in retinal specializations

Most animals use vision as the primary sense to guide their behaviour. From open grasslands to deep-sea hydrothermal vents, animals have evolved complex visual systems for the detection of light in nearly every environment. Therefore, it is not surprising that specializations in visual anatomy can be driven by an animal's visual ecology. For example, many species have discrete patterning of different photoreceptor types across the retina, termed intra-retinal variation. These spatial arrangements are tuned to maximise the efficiency of the eye during visual tasks by matching the directions of view to the properties of the visual environment that aid behaviour (e.g. detecting silhouettes of predators overhead or visual signals of colourful conspecifics) [1]. There can also be considerable diversification in variation within species, forming distinct phenotypes that may vary temporally, all driven by selection pressures specific to the local visual environment [2][3].

In this context, how has the introduction and spread of artificial light pollution affected the selective forces on animal visual systems? Light pollution is an unprecedented visual stressor and is continually expanding geographically with urban sprawl [4]. Additionally, the intensity and spectral characteristics of light pollution is changing as technology progresses [4][5]. The aim of my PhD is to provide a better comparative understanding of phenotypic variation in the eyes of a variety of species and investigate the selection pressure that artificial light pollution imposes on phenotypes and species fitness overall.

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Poster 21

Motala, Aysha, Cardiff University

Visual rhythm perception – simply the sum of its parts?

Previous experiments utilising the method of sensory adaptation have presented evidence towards a temporal 'rhythm aftereffect'. Specifically, adapting to a fast rate makes a moderate test rate feel slow, and adapting to a slow rate makes the same moderate rate feel fast. The present work aims to deconstruct the concept of visual rhythm and clarify how exactly the brain processes a regular sequence of sensory signals. We ask whether there is something special about 'rhythm', or whether it is simply represented internally by a series of 'intervals'. Observers were exposed to visual temporal rates (a 'slow' rate of 1.5Hz and a 'fast' rate of 6Hz), and were tested with single empty intervals of varying durations. Results show adapting to a given rate strongly influences the temporal perception of a single empty interval. This effect is robust across both, interval reproduction and two-alternative forced choice methods. These findings challenge our understanding of visual rhythms and suggest that adaptive distortions in rhythm are, in fact, distortions to repeatedly presented uniform intervals composing those rhythms.

Motala, A; Whitaker, D.

Poster 22

Muchhala, Mubarka, University of Bristol

The effect of dichromatic representation on affective image perception

Humans with dichromatic colour vision most commonly have an absence of red or green cones in their retina, resulting in spectral sensitivities reduced to yellow and blue hues (Simunovic, 2010). Colours have different affective associations, therefore dichromats have significantly different affective responses to colour samples compared with trichromats (Álvaro, Moreira, Lilo & Franklin, 2015; Sato & Inoue, 2016). However, given the strong influence of context in affective perception (Elliot & Maier, 2012), it is important to assess affective colour perception with contextual stimuli. As such, the current experiment manipulates the chromatic representation of natural images. Participants rated dichromatic and trichromatic images on pleasure, arousal, and dominance scales in an online survey. Significant effects of dichromacy were found for pleasure and dominance dimensions. Compared to ratings in the trichromatic condition, positive images were less positive, negative images were less negative, and dominant images were less dominant in the dichromatic condition. These findings suggest that a dichromatic representation weakened affective image perception. Given that affect motivates adaptive behaviours (Lang, 1995), this has important implications for the everyday behaviour of dichromats. However, participants were all trichromats, therefore the current evidence cannot make assumptions about affective image perception in dichromats. Further research using dichromatic participants is necessary to investigate whether affective image perception is significantly different in dichromats and trichromats.

Alex Mackin, Mariana Afonso, Fan Zhang, and David Bull

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Poster 23

Ponce Lopez, Victor, University of Bristol

Semantically selective augmentation for deep compact person re-identification

We present a deep person re-identification approach that combines semantically selective, deep data augmentation with clustering-based network compression to generate high performance, light and fast inference networks. In particular, we propose to augment limited training data via sampling from a deep convolutional generative adversarial network (DCGAN), whose discriminator is constrained by a semantic classifier to explicitly control the domain specificity of the generation process. Thereby, we encode information in the classifier network which can be utilized to steer adversarial synthesis, and which fuels our CondenseNet ID-network training. We provide a quantitative and qualitative analysis of the approach and its variants on a number of datasets, obtaining results that outperform the state-of-the-art on the LIMA dataset for long-term monitoring in indoor living spaces.

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Poster 24

Smithers, Samuel, University of Bristol

Seeing the world in a different light – visual processing of intensity and polarization to enhance target detection

Many crustaceans are sensitive to the polarization of light across their whole visual field. They use polarization cues and signals as important forms of visual information for object-based visually guided behaviours. The use of polarization in functional tasks that require parsing of visual scenes suggests that crustaceans could process polarization information in ways that enhance visual contrast across the image-forming eye. While there is some evidence to suggest that polarization and intensity information may be integrated into a single contrast channel whereby polarization directly modulates perceived intensity, this single contrast model has never been explicitly tested. Therefore, we tested the predictions of this model using a series of visual psychophysics experiments in which we determined the behavioural response probabilities of the fiddler crab *Uca tangeri* to different looming stimuli. The polarization and intensity properties of these stimuli

were adjusted independently and simultaneously using a novel type of visual display technology. We show that crabs do not integrate polarization and intensity information into a single contrast channel as previously suggested, but instead process information relating to these two modalities in discrete channels. This discovery disproves the previous hypothesis that the motion vision pathway sensitive to looming cues in crabs, and perhaps in other crustaceans, perceives polarization as variations in intensity. Instead, intensity and polarization both contribute to their own measure of contrast in early visual processing of looming cues, which then feeds into processing circuits that mediate target detection and visually-guided behaviour.

Samuel P. Smithers, Nicholas W. Roberts, Martin J. How

Poster 25

Sullivan, Brian, University of Bristol

Detecting uncertainty in a natural task

We propose an assistive system to predict a user's need for help (or uncertainty) that would function similar to an interactive video how-to-guide. The system will use task-specific training data from novice to expert. Once trained, the online system will deliver relevant video segments from expert behaviour when uncertainty exceeds a threshold. To this end, we present data from an ongoing study with preliminary analysis of recorded behaviour from participants assembling a camping tent. 24 participants answered a short survey about their experience setting up tents, then wore a head mounted first-person camera and eye tracker outdoors and were instructed to assemble a camping tent and to use printed instructions as needed. After completion, participants viewed the video from the first-person camera and rated their level of uncertainty frame-by-frame using a specialized video viewer developed in-house. Video data was manually annotated to delineate each step involved in assembly. Importantly, each time the participant referred to the instructions gave an overt indication of uncertainty. Using self-ratings of expertise, reference to instruction, and frame-by-frame uncertainty as ground truth, we analysed the data for insights into what behavioural cues might predict uncertainty. Features analysed include fixation and saccade measures, distribution and time series of assembly sequences. We are actively exploring the use of neural networks to use eye tracking and video data to predict user attention and uncertainty.

Sullivan, B

Poster 26

Wainwright, Benito, University of Bristol

Camouflage vs. symmetry: a battle between selective forces

Camouflage is a taxonomically widespread feature of animals. However, there is one thing which most of these animals have in common and that is the possession of a line of bilateral symmetry. Symmetric objects are more salient against a generally asymmetric background (Cuthill et al. 2006) thereby creating a natural paradox. Sexual selection as well as tight genetic and developmental constraints are thought to explain the relative absence of pattern asymmetry in the natural world. Nevertheless, one would expect animals to have evolved strategies which optimise their surface colouration in order to reduce the cost of bilateral symmetry.

I have taken inspiration from early experimental psychological work where it is known that object recognition is enhanced when symmetry is closer to the axis of symmetry (e.g. Barlow & Reeves 1979). By using both humans and wild birds as predators, I aim to investigate whether these ideas can be placed in a biological context. Once this is consolidated, I wish to look at real species to study whether these principles really are observable in nature, using the order Lepidoptera as a model to work with.

Wainwright, Benito

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Poster 27

Ward, Amy, University of Bristol

Investigating inflammatory eye disease

Immune activation is a common feature to most eye diseases. Our research focuses on fundamental cell biology and potential therapeutic interventions for disorders including: Uveitis, Age-related Macular Degeneration (AMD), Glaucoma, and Diabetic Retinopathy. To study these complex diseases in vivo we use murine models such as Experimental Autoimmune Uveoretinitis (EAU) and Laser-Induced Choroidal Neovascularisation (L-CNV). EAU, a model for human autoimmune ocular disease is produced by inducing an eye specific immune response or by transferring disease causing CD4+ T-cells. AMD is characterised by retinal neuronal cell loss, neovascularization and atrophy with the most destructive form modelled using L-CNV.

Several key techniques are employed to analyse underlying pathology and the outcome of different therapeutic interventions. In tissue culture, we use extracellular flux analysis for rapid quantification of mitochondrial fitness and ATP-producing respiratory processes. This is to understand the metabolic changes (e.g. Warburg effect and mitochondrial dysfunction) within retinal cells that drive the progression of AMD. In the EAU model, high resolution fundus imaging permits in vivo assessment of clinical disease, whilst quantification of immune cell infiltrate by flow cytometry allows us to study disease kinetics. Disease associated cell types are then investigated further by RNA-seq on small cell numbers, as a method of identifying novel targets.

Here we are able to showcase the variety of approaches, models, data and platforms that exist in Bristol and very much welcome collaboration with participants across the BVI and GW4.

Bell, O Scott, L Ward, A

Poster 28

Wells, Mason, Cardiff University

Mapping residual visual function in hemianopia

Homonymous hemianopia (HH), is a common visual deficit arising from lesions between the optic chiasm and the primary visual cortex (V1) (Zhang, Kedar, Lynn, Newman, & Biousse, 2006). In the case of HH, patients consciously report a loss of one half of their visual field. However, some

patients retain a level of visual function in their “blind” hemifield close to fixation, known as macular sparing.

Perimetry (visual field testing), used to diagnose macular sparing, does not account for eye movement. The systems assume that the patient is able to maintain good central fixation. However, it has been shown that patients with HH make fixational eye movements away from the fixation point while stimuli are being presented during perimetry (Bischoff, Lang, and Huber, 1995). The present study will use standard perimetry, microperimetry and a gaze-contingent perimetry system to assess if eye movements contribute to macular sparing.

Do involuntary eye movements towards the blind field during clinical diagnosis offer a plausible explanation of macular sparing? However, if macular sparing is true spared vision, does the phenomenon result from undamaged dedicated cortex?

Up to 60% of the visual cortex is responsible for processing the central 10° of our vision (McFadzean, Brosnahan, Hadley, & Mutlukan, 1994). The damage causing HH may not include the area of the brain responsible for processing the central portion of our visual field and thus a small amount of vision is retained. fMRI will be conducted to assess the topographical organisation of the damaged cortex.

Wells, M

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Poster 29

Zhang, Fan, University of Bristol

A video quality metric for spatial resolution adaptation

This paper presents a full reference objective video quality metric (SRQM) which characterises the relationship between variations in spatial resolution and visual quality in the context of adaptive video formats. SRQM uses wavelet decomposition, subband combination with perceptually inspired weights, and spatial pooling, to estimate the relative quality between the frames of a high resolution reference video, and one that has been spatially adapted through a combination of down and upsampling. The BVI-SR video database is used to benchmark SRQM against five commonly-used quality metrics. The database contains 24 diverse video sequences that span a range of spatial resolutions up to UHD-1 (3840x2160). An in-depth analysis demonstrates that SRQM is statistically superior to the other quality metrics for all tested adaptation filters, and all with relatively low computational complexity.

A. Mackin, M. Afonso, F. Zhang and D. Bull

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