Morning Talk Session

10.00-10.30

Visual integration and symmetry detection in Autism

Dr. Emma Gowen
Division of Neuroscience and Experimental Psychology, School of Biological Sciences, UoM

Autism is a neurodevelopmental condition characterized by impaired social interaction. Altered perceptual experiences are also common, possibly due to reduced integration of local information into a global percept. To explore this claim we investigated visual integration in autistic adults using a contour Integration (CI) task. CI measures a person's ability to group orientated, discrete gabor patches amid a background of randomly orientated distractor gabors and is thought to reply on horizontal connections in V1 and extrastriate feedback. CI was measured in 14 autistic and 13 non autistic participants using closed shapes (e.g. a square) and open shapes (e.g. two parallel lines). CI is better for closed compared to open shapes, termed the "closure effect" and is thought to be due to extrastriate feedback. Although both groups were better able to detect the closed shape, autistic participants showed a reduced closure effect. These results were repeated in a new group of participants using longer stimulus durations demonstrating that reduced closure in autism is not due to slower processing speeds. In a second experiment, the impact of reduced closure on symmetry perception was investigated. Studies have shown that symmetrical shapes are processed faster and preferred more by humans, and this is believed to involve a global processing mechanism. As both symmetry and closure rely on global mechanisms, it is possible that that these two processes interact and that closure might enhance symmetry detection. Experiment 2 compared symmetry detection between open and closed contours at different levels of symmetry in 14 autistic and 13 non autistic participants. Results showed that symmetry detection was better with closed than open contours for the non autistic group, but that there was no difference between the two stimuli for the autistic group with performance equivalent to closed thresholds. These findings highlight that global cues such as closure and symmetry can interact to facilitate detection of salient objects but for autistic people these "pop out" effects are reduced, potientially leading to commonly reported symptoms of sensory overload.

10.30-11.00

Colour Vision in the Natural World

David Foster
Sensing, Imaging and Signal Processing Research Group, School of Electrical and Electronic Engineering UoM

The natural world is irregular. It may be vegetated, with woodland, shrubland, herbaceous vegetation, grasses, ferns, and flowers, or nonvegetated, with barren land, rock, and buildings. The light reflected from a scene can vary from one point to another and from one instant to the next. How do these variations affect the utility of colour in different visual tasks? This presentation illustrates some of the physical limitations and failures of colour vision, and shows that they can be predicted by a generic measure of the randomness of colours in scenes. Whether an increase in randomness improves or worsens performance depends on the nature of the task.

11.00-11.30

Myopia Control Strategies

Hema Rahakrishnan

Division of Pharmacy & Optometry, School of Health Sciences, UoM

11.30-12.00

The regulation of complement transcription in the retina and its implications for AMD

Selina Mcharg

Division of Evolution & Genomic Sciences, School of Biological Sciences, UoM

Introduction Retinal pigment epithelial (RPE) cells are involved in the pathological processes underpinning age-related macular degeneration (AMD). Complement has been clearly implicated in the pathogenesis of AMD with genetic variants in complement genes modifying AMD risk. Here, we examine the transcription and regulation of complement gene transcription in both primary RPE and RPE cell lines, and whether it is altered by genetic variants in complement genes, and identify regulatory pathways of complement transcription.

Methods RPE cells isolated from adult human donor eye tissue were cultured and their RNA extracted. Quantitative polymerase chain reaction (qPCR) was used to determine the expression of a range of complement genes including *complement factor H* (*CFH*) and *complement component C3* (*C3*). Illumina Hi-Seq RNA expression analysis was performed on RNA from 12 x RPE cultures; 6 x expressing high levels of *CFH* and *C3* and 6 x expressing low levels.

Results qPCR analysis of primary human RPE cell cultures demonstrated significantly elevated CFH expression in donors who are genetically high-risk for developing AMD ($p < 0.0084$) as compared to those who are low-risk. Further qPCR analysis demonstrated that the expression levels of *CFH* and *C3* correlate significantly ($R2 = 0.521$, $p < 0.0001$). This observation was investigated further by RNA-seq transcriptome analysis of primary RPE cells which had high CFH and C3 expression, versus those with low expression. Ingenuity Pathway Analysis identified 1289 genes which were differentially expressed (fold change +/- 1.5, $p < 0.05$) in RPE cells which had high *CFH* and *C3* expression, versus those with low expression. Furthermore, there is co-regulation of the majority of alternative and classical complement genes expressed (terminal complement pathway genes and the lectin pathway are not expressed). Several canonical pathways relating to inflammation and immunology were upregulated in donors with elevated *CFH/C3* expression including IFNɣ, TNFα and IL-1β pathways. Analysis of *CFH* and *C3* putative promoter sites identified the transcription factors CEBPβ, IRF1 & 2, and STAT5A, all of which were significantly upregulated in the high expressing *CFH/C3* RPE cells.

Discussion The expression of the majority of complement genes detected in primary cultures of RPE cells is co-ordinated and there are interactions between complement gene expression and the expression of other inflammatory pathways implicated in AMD in these cells.

Afternoon Talk Session

13.30-14.00

What has melanopsin ever done for us?

Robert Lucas
Division of Neuroscience and Experimental Psychology, School of Biological Sciences, UoM

Photoreception in the mammalian retina extends beyond rods and cones to encompass a small fraction of retinal ganglion cells. These so-called intrinsically photosensitive retinal ganglion cells (ipRGCs) absorb light using a photopigment melanopsin. A long standing barrier to defining the contribution made by melanopsin photoreception to our visual capabilities has been the difficulty in stimulating melanopsin without also altering the activity of the much more numerous rods and cones. We have pioneered the use of silent substitution techniques to achieve this goal and have used them to explore the role of melanopsin in perceptual vision and reflex light responses in both laboratory mice and human subjects. I will provide an overview of that work.

14.00-14.30

Rethinking visual search

Johan Hulleman
Division of Neuroscience and Experimental Psychology, School of Biological Sciences, UoM

Everybody does visual search. Scanning the environment with your eyes to find something you are looking for is a daily part of our lives. From its conception as a research topic, the study of visual search has been governed by the assumption that visual search proceeds on the basis of individual items. This has led to a divide between search in the lab (where it is easy to define items) and search in the real world (where it is surprisingly hard to define items). In this talk I will argue that by taking fixations as the central unit of visual search the gap between the lab and the real world can be bridged more easily. A fixation-based approach also holds promise in tackling some of the more vexing aspects of real world search, where people may only have a vague notion of what they are looking for, where there actually may be multiple targets and where missing a search target may have very serious consequences.

14.30-15.00

How successful is training individuals with a central scotoma to read “eccentrically”

Chris Dickinson
Division of Pharmacy & Optometry, School of Health Sciences, UoM

Individuals with uncorrectable visual impairment experience difficulties with everyday tasks, particularly those involving reading. Whilst magnification can be effective in many cases, it does not help those individuals who have a significant central scotoma (a missing area in the centre of their visual field). A number of strategies have been suggested to help these individuals, one of which is Eccentric Viewing (EV). The Macular Society offer community-based EV training across the UK by volunteer trainers who deliver free one-to-one training, usually in learners’ homes. In the EValuation Study, which was designed to evaluate this training programme, the audio-recorded reading performance of learners was compared before and after training. Telephone questionnaires

were used to assess: life satisfaction; amount of reading performed; health- and vision-related quality of life. Learners were also interviewed to obtain their subjective opinions. A total of 121 learners completed all stages of the study. There was no significant change in maximum reading speed. A small improvement in threshold print size was found, but frequency and duration of reading did not increase. There was no change in health- or vision-related quality of life, or in the difficulty experienced in performing everyday tasks. The lack of improvement of reading speed, and modest improvement in threshold print size, should be interpreted in the context of the unique features of this EV programme. However a concurrent randomised controlled trial of EV training (the EFFECT Study) also found little evidence of improved reading performance. The goal of achieving moderate to high reading rates in individuals with a central scotoma remains elusive.

15.00-15.30

Topsy-turvy adventures in cone isolation

Neil Parry
Division of Pharmacy & Optometry, School of Health Sciences, UoM & Manchester Royal Eye Hospital

For the past few years our group having been exploring how human retinal cones behave when they are functionally isolated from their fellows. Using a technique called silent substition we can design multispectral stimuli whose change from background to test and back to background can be seen by only one class of photoreceptor, whether that be L, M or S cones, or Rods. In theory the other three classes of photoreceptor do not change their activation. Much of our work has used the electroretinogram (ERG), which uses a corneal electrode to monitor the instantaneous change in retinal electrical polarisation following a visual stimulus. Classically one uses a flash of white light, the resultant signal being said to monitor activity in photreceptors and their associated glial cells, the bipolars. When we tried L-cone isolating flashes, the resultant ERG was indistinguishable from that to a white flash. Suprisingly though, an M-cone isolating stimuli produced a onset response which looked like a white light offset response, and an offset that looked like an onset. Seemingly, the ERG thinks that, when the stimulus gets brighter for M-cones, the overall result is a dimming. Similar differences were seen between Rods, which responded conventionally, and S-cones, which didn't. But S-cone isolation is fraught with difficulty so we have largely concentrated on the L:M inversion.

Our next step was to determine whether what the ERG was telling us reflected perceptual differences. I will present a series of experiments in which we measured the M-cone dimming effect psychophysically. This confirmed our hypothesis that the ERG does indeed reflect perceptual differences: an increase in M-cone stimulation is perceived as getting dimmer. Finally, we have conducted a series of experiments to examine the pupil response to cone isolated flashes; yet again the paradox is seen.

Other than their spectral sensitivity, L cones and M cones are more or less identical, so we conclude that, somehow, cone opponency is being reflected in the ERG, hitherto thought to be indicative of earlier stages in the phototransduction cascade. Why the inversion occurs is still unclear, although our best guess is that it is related to the predominance of L-cones in the human retina (usually at least twice as many). There is, however, a wide variation in human L:M cone ratio (between about 0.8:1 and 16:1) and we are currently setting up a study to exploit this, investigating whether the scale of the effect can be titrated against L:M cone ratio.

Invited Speaker

16.00-17.00

Visual cortical adaptation in health and disease

Sam Solomon

Department of Experimental Psychology, University College London

In humans and animals adaptation is a perceptual reflex that changes how the world looks – for example, looking out of a moving train's window for a long time causes the world to appear to 'move backwards' when the train stops. This reflexive aftereffect is due to the effects of adaptation on nerve cells in the visual cortex, a form of short term plasticity which occurs automatically during exposure to visual scenes. Adaptation is a nearly ubiquitous phenomena in sensory systems and we are interested both in how adaptation induces changes in the sensitivity and selectivity of sensory cells, and whether adaptation can be used to better understand unhealthy brains. Here I present recordings from cortical neurons that suggest that adaptation's effects may arise in the same circuits that cortical neurons use to interact with each other ('normalization'). I then provide evidence for a temporal dissociation between adaptation's effects on neural sensitivity and selectivity. Finally I present preliminary evidence that adaptation's effects may provide an early indicator of cortical dysfunction in a common mouse model of neurodegeneration.