JANUARY VISION MEETING - THE COLOUR GROUP UK – WEDNESDAY 10 JANUARY 2018

ABSTRACTS

Measuring melanopsin function in humans

Manuel Spitschan, University of Oxford

The spectral, spatial and temporal properties of the retinal mechanisms underlying circadian phase shifting and melatonin suppression by bright light are an important area of investigation. Practical applications include the design of lighting solutions to minimize adverse effects of light at night, and optimizing lighting schedules to address circadian desynchronization due to shift work and jet lag. The photopigment melanopsin, expressed in a subset of retinal ganglion cells, rendering them intrinsically photosensitive, is thought to mediate these “non-image-forming” effects of light. Using the method of silent substitution, which allows for the targeted stimulation of melanopsin in humans, we have made progress in measuring and understanding the contributions of melanopsin to the pupillary light reflex and to primary visual cortex. A key focus has been on developing methods to assess the quality of isolation of melanopsin with minimal inadvertent stimulation of the cones.

Adaptation to the variability of visual information

Dr. John Maule

The Sussex Colour Group, School of Psychology, University of Sussex, Brighton, UK

The sensory signals we can detect from the world are highly variable and the brain has a large amount of information to process, encode and represent percepts. One way in which the visual system can reduce its processing load is to use summary statistics – representing the mean of features in the set, rather than individual exemplars. It has previously been found that observers are able to extract the mean hue from a rapidly-presented ensemble of colours (e.g. Maule & Franklin, 2016). This ability has been demonstrated for other stimulus domains, including orientation, size and facial expression. In addition to summary statistics of central tendency, it may also be useful for the visual system to encode information about the variation present in visual features. I will present a series of experiments investigating the encoding of variance for colourful ensembles. Ensemble variance was controlled by varying the difference in hue (in CIELUV colour space) between different elements. Observers viewed pairs of ensembles situated to the left and right of a central fixation point. During the adaptation phase there was a consistent relationship between the amount of variance in each ensemble (e.g., left more variable in hue than right). On test trials observers judged which ensemble appeared more variable. Generally, following exposure to highly variable ensembles on the left observers perceived a pair of equally variable ensembles as relatively less variable on the left compared to the right of the display. This result is similar to that shown by Norman et al. (2015)

for ensembles of orientation, suggesting that representation of the variance independent of the central tendency may be a general feature of visual coding. The results imply that perceived variability of a multi-coloured ensemble is subject to adaptation after-effects, and therefore that colour variance is an encoded property of visual sets. The value of encoding variability may be in tuning the brain to the visual properties of the immediate surroundings, allowing the brain to better predict the content of the environment and represent salient elements.

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Stacey Aston – Durham

Learning Illumination Priors for Colour Constancy

Previous studies suggest human colour constancy is best when the change in illumination chromaticity is representative of changes in daylight chromaticity – a "blue bias" for colour constancy – yet it remains unclear how such a bias is encoded in the visual system. We hypothesise that the human visual system utilises prior knowledge of daylight chromaticities – an "illumination prior" – to constrain the colour constancy problem and that this leads to the "blue bias". In this talk, I'll discuss extended results from an illumination discrimination paradigm to further explore the extent to which the "blue bias" generalises when all the illuminations used in the task are chromatically biased. In addition, I'll show results from a second task that suggest human observers are capable of forming an illumination prior over hue value for a set of atypical (unnatural) illuminations.

Jasna Martinovic & Soren K Andersen

Asymmetric cortical summation of luminance and colour corresponds to bottom-up biases in perception and attention

Most neurons in early visual areas respond preferentially both to a certain colour and to a certain level of luminance contrast. To reveal the implications of such preferential tuning for selective attention, we investigated how colour selection operates in humans when luminance and chromatic contrasts are combined. We conducted two steady-state visual evoked potential experiments. In the first, a motion detection task was performed on a single random dot kinematogram (RDK), while in the second, the same task was performed under selective attention demands on two overlaid RDKs. Our stimuli combined fixed amounts of chromatic contrast from either of the two cone-opponent mechanisms (S-(L+M) and L-M) with different levels of positive luminance contrast. In the first experiment, prominent summation asymmetries were found for bluish (S-(L+M) increment). In the second experiment, top-down attentional selection was facilitated by luminance differences between the attended and unattended colour for colours on the L-M axis, but not for S-(L+M) colours. Our results indicate that asymmetries in attentional selection of cone-opponent colours are likely to correspond to early, neural-level asymmetries in cortical processing of combined colour and luminance signals.

Kenneth Knoblauch - Inserm, France

The neural circuit for watercolor filling-in

The watercolor effect (WCE) is an assimilative, long-range, color, filling-in phenomenon induced by distant contrast edges. Psychophysical evidence provides support that it is generated in higher order visual areas (the phenomenon depends on properties not typically thought to be encoded in primary visual cortex) and that it depends on a contour integrative process (the phenomenon is disrupted if the inducing contours are disrupted and it is also selectively suppressed by contour adaptation). I present evidence from analyses of functional cerebral imaging that implicates a role of feedback from dorsal stream areas on primary visual cortex and cross-stream influences onto the ventral stream in the WCE, while uniform chromatic fields generate a complementary pattern of activity mediated by feedback from ventral stream areas. The results demonstrate that color appearance from filling-in and uniform chromatic fields is mediated by different circuits.

Andy Rider, UCL

A novel colour illusion and a nonlinear model of ON and OFF pathways

At moderate temporal frequencies, alternately flickering red and green lights take on a mean yellow appearance, but the mean colour can be altered dramatically by changing the shapes of the flickering waveforms, even though the mean chromaticity and luminance were held constant. Such changes imply that there must be significant nonlinear stages in colour vision processing. We have developed a physiologically-based model of chromatic processing in the early visual system that can account for this intriguing colour illusion. The model places the important nonlinear stage at the early separation of visual signals into incremental (ON) and decremental (OFF) signals.

Graham D. Finlayson - University of East Anglia

Eyeteq: Helping colour deficient observers to see more while maintaining colour fidelity for all.

Colour deficient observers have ‘reduced’ sensitivity with respect to one cone class typically the long- or medium-wave sensitive mechanism indicating respectively protanopia and deuteranopia. There is a growing industry in providing either physical aids (coloured filters) or automated image processing software to mitigate the effects of colour deficiency. With respect to image processing, Daltonisation algorithms seek to ‘add in’ the colour signal invisible to a colour deficient observer to the signal they can see. The extent this works is debatable but most of these algorithms make images which look quite different - and much less preferred - to the originals (for colour normals and colour deficient observers alike).

The idea behind Eyteq is to treat colour deficiency as an image fusion problem. In a well defined mathematical way - which I will present in the talk - we fuse the detail a colour deficient observer can't see with that which is visible. By design, the algorithm also produces images which are close to the original. As a result the Eyeteq algorithm produces images which are strongly preferred by the majority of colour deficient observers (and also help them pass colour deficiency tests) but where the colour fidelity is, more or less, maintained for colour normals. The efficacy of our approach is tested via a third party evaluation.