Kongsberg Vision Meeting 2014: Abstracts

Kongsberg Vision Meeting was arranged at Buskerud University College in Kongsberg for the seventh time on October 27, 2014. Rigmor C. Baraas and Gaute T. Einevoll organised the meeting. Keynote speakers were Joseph Carroll from the Medical College of Wisconsin, Milwaukee (USA), and Li Zhaoping from the University College London, London (UK). The abstracts from the talks are presented in the order they were given.

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Imaging Photoreceptor Structure with AOSLO: Recent Advances

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Abstract

The human retina is a readily accessible tissue, and can be imaged using a number of different modalities. The ability to directly visualize the living retina provides an implicit advantage in diagnosing and monitoring retinal disease, however the available resolution of clinical tools is limited. Adaptive optics (AO) enables correction of the eye's monochromatic aberrations, and as a result provides nearly diffraction-limited imaging. AO can be deployed using a conventional fundus camera ("flood-illuminated"), scanning light ophthalmoscope (AOSLO), or optical coherence tomography (AO-OCT). Our current AOSLO systems are capable of imaging the smallest photoreceptor cells in the living retina, rods and foveal cones.In all AO images of the photoreceptor mosaic, there is marked variability in the reflectivity (intensity) of individual cones and rods (Carroll et al., 2012; Cooper et al., 2011). Moreover, cellular reflectivity has been shown by many groups to vary over time. Recently, we have observed reductions in cone reflectivity in a variety of retinal conditions such as ocular trauma, congenital achromatopsia (ACHM), acute macular neuroretinopathy, and red/green colour blindness. We will describe our recent findings demonstrating genotype-dependent differences in cone reflectivity in ACHM (Dubis et al., 2014), and discuss the potential utility of using cone reflectivity as a biomarker of cone health.With the expanding use of AO imaging has come an appreciation that significant cellular damage can exist in the presence of "normal" anatomy on conventional imaging modalities. This was first demonstrated in red/green colour blindness (Dubra et al., 2011; Kocaoglu et al., 2011), and we will provide an update on cone structure in these patients. We will also describe our efforts in using AOSLO imaging to advance our understanding of various ocular conditions, such as inherited retinal degenerations and ocular trauma. The clinical value of these images can be appreciated through comparison of AO images with those obtained with conventional imaging tools.Finally, as novel therapeutic strategies emerge for retina degenerations, it is becoming increasingly important to devise robust tools with which to assess photoreceptor structure. We will discuss the challenges and opportunities for AOSLO imaging to be used in these efforts, using achromatopsia as an example (Dubis et al., 2014; Sundaram et al., 2014).

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Modelling retinal curvature from ocular biometry

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Abstract

Hyperopic peripheral retinal defocus (more prolate retinal curvature) has been correlated with myopia development. A better understanding of the retinal curvature may give insight into the development of refractive errors. Here a method for how the retinal curvature can be modelled from discrete ocular length measurements by partial coherence interferometry (IOLMaster, Carl Zeiss Meditec AG, Jena, Germany) is presented.

A conventional axial length (A-scan) measurement does not convey enough information to understand how well focused the retinal image is. Instead, four A-scan measurements were taken with an IOLMaster at approximately ± 20 degrees sagittal and transverse of the fovea in addition to axial lengths measurements, from 27 healthy young males (mean age 24.3; range 20–38).

From these data points different models were fitted to try to understand the relationship between ocular lengths and retinal curvature. The best fitting model was a compound model comprising of a simplified schematic eye model with a much larger, flattened (oblate) ellipsoid passing through the 5 measured data points.

The model suggests that the retina does not have a uniform curvature throughout, but is flattened around the central retina.

What is it about yellow?

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Abstract
Single cone-type spatial acuity was tested with a Sloan E letter of fixed cone contrast presented at 5 deg eccentricity. The colour of the letter was blue (S-cone increment), yellow (S-cone decrement) or red (L-cone increment). Spatial acuity was tested at different levels of cone contrast. Observers aged 20–45 years were included. The observers' colour vision phenotype and cone-opsin genoptypes were known from previous studies. Single cone-type spatial acuity increased with increasing cone contrast for all observers with normal colour vision regardless of stimuli colour. Observers with tritan colour vision deficiencies performed as normal trichromats for red and blue letters, but not for yellow letters. The results are discussed in terms of differences in circuitry for S-cone signalling.

Understanding behavioural thresholds in discriminating the wavelength of monochromatic light from properties of cones and retina

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Abstract
We show that human ability to discriminate the wavelength of monochromatic light can be understood as *maximum likelihood decoding of the cone absorptions*, with a signal processing efficiency that is independent of the wavelength. This work is built on the framework of ideal observer analysis of visual discrimination used in many previous works. A distinctive aspect of our work is that we highlight a perceptual confound that observers should confuse a change in input light wavelength with a change in input intensity. Hence a simple ideal observer model which assumes that an observer has full knowledge of input intensity should over-estimate human ability in discriminating wavelengths of two inputs of unequal intensity. This confound also makes it difficult to consistently measure human ability in wavelength discrimination by asking observers to distinguish two input colours while matching their brightness. We argue that the best experimental method for reliable measurement of discrimination thresholds is the one of Pokorny and Smith (1970), in which observers only need to decide whether two inputs appear different from each other, regardless of whether they differ in hue or brightness. We mathematically formulate wavelength discrimination under this wavelength-intensity confound and show good agreement between our theoretical prediction and the behavioural data. Our analysis explains why the discrimination threshold varies with the input wavelength, and shows how sensitively the threshold depends on the relative densities of the three types of cones in the retina (and in particular how it predicts discriminations in dichromats). Our mathematical formulation and solution can be applied to general problems of sensory discrimination when there is a perceptual confound from other sensory feature dimensions. A pedagogic explanation of this work can be found in the original publication (Zhaoping, Geisler, & May, 2011), or (Zhaoping, 2014) which also explains additional examples of visual discrimination as maximum-likelihood decoding.

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A Neurophysiologically Based Analysis of Lightnessand Brightness Perception

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Abstract
Visual, achromatic luminance threshold and scaling data have been analyzed and found to be derivable from nonlinear responses of retinal cones. For short (0.1s) stimulus duration a stable state of visual adaptation could explain the threshold response, but for longer durations a change of adaptation had to be considered. This resulted in a contrast sensitivity that increased when the stimulus duration increased and became constant for higher test field luminances. Threshold and scaling data can thus be traced back to cone responses over a much larger range of stimulus intensity than previously anticipated. The idea of combining cone responses with adaptive changes to describe visual responses resulted in a single cone-based response formula for describing both luminance threshold and scaling data.

Local field potentials and network dynamics in a model cortical column of cat V1

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Abstract
The local field potential (LFP) is the low frequency part of extracellular electric potentials recorded by sharp electrodes directly in neural tissue. The LFP originates from transmembrane currents, and reflects ongoing activity in the tissue surrounding the recording electrode. Although the biophysical

origin of the LFP is relatively well understood in terms of spatial spread, dependency upon cell type, synapse distribution and correlations through modelling studies (Binzegger, Douglas, & Martin, 2004; Einevoll, Kayser, Logothetis, & Panzeri, 2013), interpretation of LFP remains ambiguous in terms of ongoing network activity because of the many possible contributing sources. However, large-scale models addressing network interactions typically use simplified spiking neuron descriptions using efficient, one-compartment point processes, but relating model network activity to easy-to-measure extracellular potential remains nontrivial, mainly due to lack of detailed cell morphologies. The present study aims to provide methods for computing LFPs from point-neuron networks using biophysical principles behind extracellular potentials. Here, we relate spiking activity with LFPs in a model cortical column under $1mm^2$ of primary (visual) sensory cortex (Gewaltig & Diesmann, 2007). The model is composed of 78000 cells spread across layer 2/3 to layer 6 with one excitatory and one inhibitory population per layer. The network model use one-compartment leaky integrate-and-fire model neurons implemented in NEST (Hines, Davison, & Muller, 2009). The spiking activity of the network model is used as the synaptic input to morphologically detailed multi-compartmental neurons, which in turn generate the LFP (implemented with LFPy (Izhikevich & Edelman, 2008) using NEURON (Lindén et al., 2011)). The overall cell-type and layer-specific connectivity preserve the connectivity of the spiking network model and further anatomical data (Lindén et al., 2013; Potjans & Diesmann, 2012). Our results show that both spontaneous and stimulus-evoked LFPs depend critically on the level of synchrony in the underlying network state. Besides, we show that full-scale simulations, i.e., simulations including all cells in the network, are required to address the effect of network correlations on the LFP. Given the widespread use of point-neuron network models and the previous lack of tractable methods to associate their activity to easy-to-measure signals (e.g., LFPs), the present method is a step toward gaining important insight into the link between experimental measurements and the underlying network activity.

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Stem Cell Therapy of the Ocular Surface – Current Possibilities and Limitations

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Abstract

The purpose was to evaluate the role of stem cells in future ocular surface reconstruction based on a thorough review of the literature; and to analyze the usefulness, current feasibility and challenges of storage and transportation of cultured cells. The literature review was based on the search word *limbal* in PubMed (i.e., more than 3000 abstracts or papers), and interpretation of own data (published and unpublished) on culture and storage of a number of cell types for treating limbal stem cell deficiency (LSCD). The review revealed a number of cell-based strategies in the treatment of LSCD and other ocular diseases over the past 64 years. As early as 1940 amniotic membrane was used. Fifteen years later, transplantation of conjunctival-limbal-corneal epithelium marked the first limbal stem cell transplantation. The first application of cultured cells dates back to 1997, with the use of limbal cells. In order to treat bilateral LSCD using autologous sources, several alternative cell types have been proposed during the past decade. This strategy is of particular interest in order to circumvent issues related to allografts, such as graft rejection and transmission of microorganisms. More recently, non-cell based approaches, such as electrotherapy, steroid pulse therapy, oxygen therapy, and various eye drops have emerged. The feasibility of storage of cultured limbal epithelial cells has been demonstrated for more than a decade. The possibility of storage for at least some days has several important implications: Increasingly tougher regulations for cell therapy coupled with the need for more advanced technology are likely to lead to the centralization of highly specialized culture laboratories. Gathering of state-of-the-art equipment and expertise is a favourable consequence of centralization. However, it necessitates effective transportation strategies, for which storage technology is mandatory. Moreover, an effective storage method addresses surgery/patient scheduling issues and allows time for quality and sterility control of cultured cells. In conclusion, a multitude of new treatment options have recently emerged which offer new possibilities in the treatment of LSCD. In addition, the option of storage of cultured cells makes therapies previously restricted to highly specialized culture units available worldwide.

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Postgraduate Optometry Students' Person-Centred Communication Skills: The Person-Centred Communication with Older Persons in Need of Health Care (COMHOME) Study

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Abstract

Good communication is a prerequisite for good quality in person-centred health care (Ammentorp, 2012). The medical interview includes three functions: (i) building an effective relationship, (ii) assessing and understanding the patient's problems, and (iii) collaborating for management (Cole & Bird, 2014). The aim is to describe self-reported communication skills of optometrists in postgraduate education. The study had a cross-sectional descriptive design. The target population was postgraduate optometry students (n=37) at Buskerud and Vestfold University College. Evaluation of students' communication skills self-efficacy was collected using the questionnaire "Clear-cut communication with patients" (Eide & Eide, 2007). Thirty-three students (89%) completed the questionnaire, 82 % were female. All had work experience and 85% combined work and education. The majority considered it important or very important to succeed in: (i) encouraging the patient to elaborate and explain their concerns (91%) and express their thoughts and feelings (67%), showing appropriate non-verbal behaviour (91%) and empathy (91%), (ii) planning (82%) and structuring (82%) the interview and identifying issues important to the patient (97%), and (iii) understanding the patients' knowledge to provide adequate amount of information (85%), ensuring that the patient understood the information given (100%), making a plan based on shared decision (90%) and closing the session and ensuring that the patient has received answers to their questions (100%). They were also sure or very sure of succeeding in doing so. However, the optometrists were less confident of succeeding in managing emotional and angry patients and relatives, breaking bad news and managing their time with the patients. Effective communication can have a significant effect on health in older people and further studies are needed to explore person-centred communication in optometric practice and the effect of training optometrists in communication skills.

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