Kongsberg Vision Meeting 2013: Abstracts

Kongsberg Vision Meeting was arranged at Buskerud University College in Kongsberg for the sixth time on December 10, 2013. Rigmor C. Baraas and Gaute T. Einevoll organized the meeting. Keynote speakers were Michael Crossland from Anglia Ruskin University and Moorfields Eye Hospital, London (UK), and James A. Bednar from the University of Edinburgh (UK). The abstracts from the talks are presented in the order they were given.

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Visual function in early macular disease

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Abstract

As treatment for sight threatening eye disease becomes more advanced, the number of people with early stage vision loss increases. In this presentation I will discuss the identification, functional impact, and rehabilitative challenges of early macular disease. I will present data emphasising the effect of early macular disease on dark-adapted visual function and will discuss the novel technique of dark-adapted microperimetry. I will also identify future research needs and the likely impact of early macular disease on clinical low vision work.

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Improving vision care among older people: Training programs to enhance competence among multidisciplinary hospital and nursing home staff

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Abstract

We have previously reported that vision and hearing loss are common among residents in Eikertun nursing home (Falkenberg, Langeggen, & Dugstad, 2009). These are also common in older people living at home, and, generally, there is little awareness about vision loss in ageing among older people (Horgen, Eilertsen, & Falkenberg, 2012). Dual sensory loss is shown to exacerbate other physical and emotional disabilities. In stroke patients, visual impairments are common, affecting more than 60% of all survivors. The extent and severity of vision loss varies greatly, but is frequently associated with additional distress (Eilertsen, Kirkevold, & Bjørk, 2010; Tsai, Cy, Hsu, Liu, & Chou, 2003; West et al., 2002). Although the specialist health care services are aware that vision problems frequently occur in stroke patients, these problems are inadequately documented, and no systematic assessment, treatment or rehabilitation strategies for visual functions exist (Helsedirektoratet, 2012).

There is a large risk that patients are discharged from hospital without being screened for vision problems or referred appropriately. Results from Eikertun nursing home indicate that the eye/ear health care could be improved by regular examinations, as the majority of vision and hearing problems were due to uncorrected refractive errors and lack of hearing aids.

Findings from three projects aimed at competence enhancement and skill development in hospital and nursing home staff, in order to improve the vision care provided to stroke patients, nursing home residents and normal ageing, will be presented. Results from the on-going stroke training programme we have developed in collaboration with Vestre Viken Hospital Trust and the Norwegian Stroke Association will be reported. Further, experiences from applying a multidisciplinary approach to skill transfer will be summarized, and the optometrist role in vision health promotion will be discussed.

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Work opportunities with low vision

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Abstract

The aim of this study was to enhance follow-up routines for low vision patients in employment, who were registered with The Norwegian Labour and Welfare Administration, Low Vision Clinic (NLW-LWC) and Kongberg Community Council, Buskerud, Norway. Statistics published by the Norwegian Association of the Blind (Gleinsvik, Klingenberg, & Thorbjørnsrud, 2012) state that 25-40% of all visually impaired in the working age group are in employment. There is no literature referring to the role of NLW-LWC and community council cooperation to enhance low vision rehabilitation for this group of patients. For this study patients in the working age group were recruited from the list of candidates given by either the Kongsberg Community Council optometrist or the NLW-LWC optometrist. All participants were contacted and asked to sign the consent form before they were included in the study. Interviews of the subjects were based on a questionnaire concerning general health, mobility, work situation, use of visual aids at work and at home, and experience with visual rehabilitation. All subjects included in the study were eligible for low vision aids. Ages ranged from 32–59 years. Of the 13 subjects six males and four females were interviewed. Only one subject was born with his low vision condition, all had completed education to high school level and one had a master degree. None worked in a health care profession. Eight of ten worked on a computer daily, where only one used Zoomtext. Visual acuity ranged from 0.15–1.2 (Snellen decimal). Visual field was reduced in nine of ten

subjects, all from central to right temporal hemisphere scotomas. Six of ten used filter spectacles, although only two used them frequently. Magnifiers (4/10), near and reading magnifying spectacles (7/10) and computers (7/10) were the preferred low vision aids. These visual aids were used both at work and at home. None had experienced a systematic approach to their low vision situation, most follow-ups where through the local optometrist (7/10). Subjects were positive to the questionnaire and emphasized the need for regular follow-up by optometrists with low vision specialist competence. To enhance low vision rehabilitation and to provide better work situations for visually impaired employees, it is necessary to look at both the work situation and the home situation. There is a need for a more systematic approach towards this patient group. The optometrist is essential in optical low vision follow-up, and the NLW needs to focus on technical support, illumination, legal rights and dialog with the work place. Our questionnaire can be a useful tool in the care of these patients. It is the NLW's responsibility to put forward routines for cooperation with local optometrists in private and public positions to improve support and follow-up for this patient group.

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A mechanistic model of the development and function of the primary visual cortex

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Abstract

Why is development relevant for understanding how the primary visual cortex (V1) works? In this talk, I outline results from a long-term project to explain how a large fraction of the observed functional and structural properties of V1 neurons can arise from a small set of biologically plausible computational mechanisms (Bednar, 2012; Stevens, Law, Antolik, & Bednar, 2013). Using Hebbian learning and homeostatic plasticity driven by natural images, model neurons develop responses for all of the observed visual feature dimensions, with preferences organized into topographic feature maps, such as for orientation and motion direction, and specific patchy lateral connectivity that reflects multiple overlaid maps. This self-organized structure then explains complex and seemingly arbitrary functional properties such as diversity in surround modulation properties, specific visual aftereffects, and contour completion. Fundamentally, the connection patterns capture the range of and correlation between features of the visual environment experienced during development. This structure then determines the range of stimuli that can be represented, while modulating the responses to reduce redundancy and to make statistically plausible inferences about noisy or incomplete stimuli. This mechanistic, developmental modelling approach leads to experimentally testable predictions at each stage, and it can also be applied to understanding other sensory cortices, such as somatosensory and auditory cortex.

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Functional consequences of the distribution of T-type calcium channels in interneurons of the dorsal lateral geniculate nucleus

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Abstract

Visual information from the retina is conveyed through the optical nerve to relay neurons (RNs) in the dorsal lateral geniculate nucleus (dLGN), a part of the thalamus which transmits processed information to the primary visual cortex. The activity of the RNs is modulated by feedforward inhibition provided by local GABAergic interneurons (INs). This inhibition is thought to refine the receptive fields of RNs, and generally to control information flow through the thalamus.

One important feature of interneurons is that their dendrites have a dual role. In most neurons, dendrites serve solely as input channels, i.e. they receive input from other neurons, but in the INs, distal dendritic sites can both receive input (from retina) and deliver GABAergic output to RNs. The conditions for dendritic output are not fully understood, but it is known that it may be triggered both by local synaptic input and by somatic activity. The function of the IN thus depends on the way signals propagate along the dendrites in both directions, i.e. both how synaptic input to distal dendrites is conveyed to the soma, and how somatic signals are conveyed to the distal dendrites.

T-type calcium (I_T) channels play an important role in thalamic cells. These channels mediate the generation of calcium-spikes, which are relatively slow depolarizations of the membrane potential that often evoke bursts of action potentials. In other neuron types, the distribution of I_T – channels over the somatodendritic membrane is believed to critically influence several aspects of neuronal function, including synaptic integration and the influx of calcium in the cell. We hypothesize that it will also play a crucial role for the dendritic signaling in LGN INs.

Available data on I_T channel distribution in INs is scarce and not always in agreement (Munsch, Budde, & Pape, 1997; Parajuli, Fukazawa, Watanabe, & Shigemoto, 2010). Using adaptations of a multicompartmental model of an IN, we therefore tested a number of different scenarios. We constructed different versions of the model where the I_T channel density (i) increases linearly with distance from the soma, (ii) is uniform throughout the neuron, (iii) is concentrated in the soma, and (iv) is concentrated in the distal dendrites. We compare the simulation results for the different scenarios (i-

iv) in order to find an optimal distribution of I_T channels for different aspects of IN signaling, including somatic response to somatic stimuli, propagation of somatic signals to the dendrites, and propagation of synaptic signals from distal dendrites to the soma. Finally, we discuss which of the model versions (i-iv) are in best agreement with the IN signaling properties reported in previous literature.

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Biophysically detailed network model for area summation in LGN relay cells

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Abstract

The lateral geniculate nucleus (LGN) acts as a gateway for visual signals to reach the visual cortex. Despite its prominent position in the early visual pathway, and the relative abundance of anatomical and physiological data recorded from the nucleus, the functional role of the LGN is still poorly understood. Mathematical modeling will clearly have to be a key component in elucidating its function.

The principal cell type in the LGN is the relay neurons (RNs), which relay processed retinal information to the cortex. The activity of the RNs is modulated by feedforward inhibition provided by local GABAergic interneurons (INs). A striking feature of the LGN circuit is that INs and RNs are known to form triadic synapses. At these sites, a single retinal terminal provides excitatory input to both the IN and the RN dendrites. In the same site, the IN may also release GABA, and thus provides inhibitory input to the RNs (Sherman, 2004). GABA-release from the INs may be triggered directly by the local retinal ganglion (RG) input, providing a localized source of inhibition of RNs, which may be functionally decoupled from the IN soma. In addition to the complex triadic action, the INs also provide standard, axonal inhibition of RNs. The functional role of this intricate triadic circuitry is not fully understood.

Based on experiments with flashing circular spots (Ruksenas, Fjeld, & Heggelund, 2000), Einevoll and Heggelund (2000) developed a computational firing-rate model to account for the changes in the spatial response properties of RNs compared to their RG input. In accordance with known anatomy and physiology, the RNs in the model received excitatory input from single RG neurons and indirect feedforward inhibition from INs, which in turn received input from of a handful of RG neurons. This model successfully accounted for the observed spatial responses in RNs, i.e., the experimentally observed response vs. spot-diameter curves. No previous model has, however, distinguished between the various possibilities of inhibitory action from INs to RNs, i.e., whether the inhibition was predominantly triadic or axonal. A key reason is that biophysically detailed neuron models for INs have been lacking.

Our group recently developed the first comprehensive multicompartmental IN model, including active dendritic conductances placed on anatomically reconstructed cell morphologies (Halnes, Augustinaite, Heggelund, Einevoll, & Migliore, 2011). Using this model, we here develop a biophysically detailed neural network model designed to be analogous to the firing-rate network model in Einevoll and Heggelund (2000). The high level of biophysical detail allows us to explore the different roles of triadic versus axonal inhibitory action in shaping the measured spot-response curves in LGN cells.

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Multiscale modeling of the early visual pathway

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Abstract

Several ambitious large-scale efforts are on the way to try to bridge microscopic and macroscopic scales in the brain, that is, ultimately link the properties of molecules in neurons to behavior of the animals. Prominent examples of such projects are:

- EU's Human Brain Project (www.humanbrainproject.eu)
- the BRAIN Initiative in the US (en.wikipedia.org/wiki/BRAIN_Initiative), and
- Project MindScope at the Allen Brain Institute in Seattle (www.frontiersin.org/10.3389/conf.fncom.2012.55.00033/event_abstract).

A keyword here is "multiscale" modeling. In the presentation I will, based on ongoing work in our group at Ås (compneuro.umb.no) on multiscale modeling of early sensory pathways, discuss some of the challenges that must be met in the development of such models.

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Polymorphisms at specific amino acid residues in L- and M-pigment genes predict variation in chromatic discrimination

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Abstract

Variations in the amino acid sequences of the cone opsins are responsible for spectral tuning of the photoreceptors (Nathans, Piantanida, Eddy, Shows, & Hogness, 1986; Nathans, Thomas, & Hogness, 1986). There are great variations in the amino acid sequences of the L- and M-cone opsin genes even among subjects with normal trichromatic colour vision (Neitz, Neitz, & Grishok, 1995; Winderickx, Battisti, Hibiya, Motulsky, & Deeb, 1993). The aim here was to explore polymorphisms at specific amino acid residues known to affect spectral tuning to see how it influenced chromatic contrast sensitivity and discrimination ability for normal trichromats and carriers of colour vision deficiencies.

Normal trichromats, carriers of protan deutan deficiencies aged 20-45 years were included in the study. The subjects were healthy with no known ocular abnormalities. The subjects were tested with a battery of colour vision tests. Their statuses of either normal trichromat or carrier were confirmed by family history and genetic analysis of the genes encoding the L- and M-cone pigments. Chromatic contrast sensitivity was estimated in all subjects using a novel pseudo-isochromatic grating stimulus (Dees, Gilson, & Baraas, 2013).

Polymorphisms at position 180 and 230 of the red pigment gene were found to influence chromatic contrast sensitivity and discrimination ability.

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Associations between glare, eyestrain and neck and shoulder pain during computer work

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Abstract

Computer work and musculoskeletal complaints in the neck and shoulder area are both common in today's working life (Wærsted, Hanvold, & Veiersted, 2010). To avoid neck, shoulder and back symptoms during computer work, focus has traditionally been on optimizing sitting posture and optimal placement of computer screen, keyboard and mouse. However, studies also show that visual discomfort in computer work is related to pain in the neck and shoulder area (Helland et al., 2008), that visually demanding computer work causes significant increase in eye-related pain (Thorud et al., 2012) and that there is an association between sustained eye-lens accommodation at near and a risk for myalgia in m. trapezius (Richter, Bänziger, Abdi, & Forsman, 2010; Richter, Bänziger, & Forsman, 2011). The proposed relationship between visually demanding computer work and discomfort in and around the eyes and in the neck and shoulder area indicates the need to also consider the visual conditions and visual function in computer users to prevent musculoskeletal disorders and eye-related symptoms.

This study investigates how exposure to glare during reading on a computer screen affects the development of eyestrain, neck- and shoulder pain. The study investigates associations between symptoms and muscle load and muscle blood flow in m. orbicularis oculi and m. trapezius.

The subjects included in the study were aged between 18 and 30 years old. All test subjects were given a full optometric examination before testing to exclude the possibility of eye problems affecting the test measurements. All testing was carried out at the same optimized computer work place, which was individually adjusted and with appropriate lighting. The assignment was to read a text on a computer screen. The test session was divided into two parts with a rest session in between; 30 minutes reading in an optimal work place environment and 30 minutes reading with exposure to glare. The order of the test sessions was controlled and stratified to exclude the possibility for biased samples. During testing muscle load and muscle blood flow were measured unilaterally on m. trapezius and m. orbicularis oculi using electromyography and photopletysmography, respectively (Thorud et al., 2012). Inclinometers were used to measure postural angles to control the sitting position (Aarås & Stranden, 1988). Before, during and after the test sessions Visual Analogue Scales (Kildesco, Wyon, Skov, & Schneider, 1999) were used to register different subjective symptoms.

Preliminary results indicate that exposure to glare during computer work affects the computer worker by increasing the muscle activity in m. orbicularis. The preliminary results also indicate a higher incidence of tiredness in and around the eyes, dry eyes, light-sensitivity and discomfort/pain in the neck during computer work with exposure to glare compared to computer work with optimal conditions.

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Spatial sensitivity, colour stability and surround suppression in the LGN

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Abstract

Responses of macaque cells in the Lateral Geniculate Nucleus (LGN) have been measured for different sizes of chromatic and achromatic stimuli, with relative luminance spanning a range up to 6 log units. Homogeneous illuminated test-fields of sizes between 0.2° diameter and $4^\circ \times 5^\circ$ were used. Responses to these stimuli deviated from what is obtained for grating stimuli, successfully used to study visual contrast-sensitive mechanisms. For test fields smaller than the center of the receptive field both the excitatory and the inhibitory cone opponent components were present in the response. The sensitivity to both components increased with the same factor when the test field increased in size (area summation). For test field areas extending into the suppressive surround of the extra-classical receptive field (ECRF), the excitatory and the inhibitory cone opponents were both suppressed, again by the same factor It has been shown earlier that a constant balance between the excitatory and the inhibitory components, independent of test field size, is a prerequisite for perceiving the same colour (here called colour stability), independent of stimulus size. The suppression of the cell's responsiveness, as function of test spot area, was described by a logarithmic function, and the spatial sensitivity of attenuation could therefore be described by a power function of radius. The logarithmic suppression was clear for parvocellular (PC) and koniocellular (KC) cells, but was more prominent for magnocellular (MC) cells. The surround field suppression was also found for the prepotential inputs to LGN cells, indicating a retinal origin. The question is raised if the so-called extra-classical receptive field (ECRF) of LGN cells is a result of adaptation generated in the retina.

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