Kongsberg Vision Meeting 2015: Abstracts

Kongsberg Vision Meeting was arranged at Buskerud University College in Kongsberg for the eighth time on November 18-19, 2015. The meeting was organised as part of the opening week of our new building, Krona. It is was the first time the meeting had both a research day and a clinical continuing education day. Rigmor C. Baraas, Bente Monica Aakre and Ann Elisabeth Ystenæs organised the two-day meeting. Keynote speakers for the clinical day were Randy Kojima from Precision Technology Services, BC (C) and Christine Wildsoet from the University of California Berkeley, California (USA). Keynote speakers on the research day were Christine Wildsoet from the University of California Berkeley, California (USA) and Mark Mon-Williams from the University of Leeds, Leeds (UK). The abstracts from the invited and contributed talks and posters are presented in the order they were given.

Received November 1, 2015, Accepted November 17, 2015.

Animal Model Studies – The Road to Improved Understanding of Myopia & Its Control

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Abstract

Myopia, which can be attributed to the eye being excessively long in most cases, was considered a near untreatable condition for many years. However, translation of results from studies involving animal models has dramatically changed this situation. Such studies have provided critical new insights into the local ocular mechanisms underlying myopia and related pathologies, as well as the understanding, refinement and/or development of optical and pharmacological treatments for controlling myopia progression and rehabilitating high myopia. This presentation will provide an overview of recently developed novel multifocal optical treatments, as well as findings implicating the retinal pigment epithelium and microRNAs in defocus-driven eye growth regulation and myopia.

Vision beyond one wavelength: Transverse chromatic aberration in the human eye

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Abstract

Transverse chromatic aberration (TCA) is one of the largest optical errors affecting the peripheral image quality in the human eye. The natural TCA increases with off-axis angle in the eye, and all spectacles induce additional TCA in the periphery. However, the exact magnitude of natural transverse chromatic aberration in peripheral vision, and the effect of spectacle-induced TCA on peripheral vision is largely unknown. The aim of this study is to apply a new image-based approach to measure for the first time objectively the natural TCA at different eccentricities within the human visual field (Winter, Sabesan, et al., 2015). Furthermore, the study evaluates how induced TCA affects visual acuity for central as well as peripheral vision (Winter, TaghiFathi, et al., 2015).

Firstly, for evaluating the natural TCA, the TCA was measured across the central 30 degrees visual field. Retinal images were taken interleaved at two different wavelengths (543 nm and 842 nm) in an adaptive optics scanning laser ophthalmoscope (AOSLO) and were cross-correlated subsequently. Accurate pupil alignment was monitored with a pupil-camera. To obtain appropriate measures of human eye TCA, the contributions of the AOSLO system TCA were examined using an on-axis aligned model eye and subtracted from the human eye data. Secondly, additional TCA was induced by trial lenses with varying prismatic power. Monocular visual acuity was studied in the fovea and in 20° nasal visual field. Monochromatic aberrations were compensated for by an adaptive optics system also during all these measurements.

In the measurements of the natural TCA, the system TCA was stable at around 3 arcmin. On all subjects, it was possible to measure TCA up to 10° – 15° out in the different visual fields. The absolute magnitude of TCA between green and IR varied between subjects to some extent, but was approximately 4 arcmin at 10° eccentricity in the nasal visual field. However, the increase in TCA was found to be linear with a rate close to 0.2 arcmin / degree of visual field eccentricity for all subjects. When inducing additional TCA under adaptive optics correction, peripheral vision was more sensitive to induced TCA than foveal vision (0.057 ± 0.012 logMAR/arcmin compared to 0.032 ± 0.005 logMAR/arcmin).

The first objective measurement of the TCA of the human eye across the central 30 degrees visual field was performed. The magnitude of 4 arcmin of TCA at 10° off-axis is very similar to the visual acuity of about 3 to 5 arcmin in the same retinal location. Additionally, the measured receptor size in the subjects of this study was about 1.4 – 1.7 arcmin, which means that the TCA blur covers around 2-3 receptors. Therefore, the peripheral natural TCA can be visually significant. Additionally, the prismatic effect of highly dispersive spectacles may further reduce the ability to detect objects in the peripheral visual field.

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Acknowledgements

European Commission (EC) (PITN-GA-2010-264605); Vetenskapsrådet (Swedish Research Council) (621-2011-4094)

Prevalence of refractive errors and colour vision deficiencies among Norwegian high school students

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Abstract

The purpose of this study was to determine the prevalence of refractive errors and colour vision deficiencies among students in a Norwegian high school.

A cross-sectional study was carried out in a high school in

a village in Eastern-Norway. 340 students (50.3%) completed a digital questionnaire; 226 (143 females) of these, aged 16–25 years (mean=17.9), agreed to participate in the vision screening. Measurements of objective refractions were obtained with Huwitz HRK-8000A Auto-REF Keratometer after administering Cyclopentolate 1%. Ocular axial length (AL) and corneal radius (CR) were measured with Zeiss IOLMaster 500. Colour vision was tested with Ishihara (24 plates edition (ed.)) and Hardy-Rand-Rittler (4^{th} ed.) pseudo-isochromatic plates according to guidelines under controlled illumination.

From the questionnaire, headache (often or sometimes) was reported by 31%. Many reported that they needed a break of at least five minutes after 15 minutes (20%) or 30 minutes (33%) near work.

Refractive status was determined as the spherical equivalent refraction (SER) for the right eye. The correlation between right and left eye was significant for SER, CR and AL ($r>0.94$, $p<0.001$). The prevalence of myopia (SER≤ -0.50 D), emmetropia (>-0.50 D to $<+1.000$ D), mild hyperopia ($\geq+1.000$ D to $<+2.000$ D) and moderate to high hyperopia ($\geq+2.000$ D) were 19%, 59%, 15% and 7%, respectively. In the group of moderate to high hyperopia, 53% were uncorrected. Only 16% of those with myopia were uncorrected. Astigmatism (cylinder refraction $\geq$0.750 D) was found in 17%, and 54% of these were uncorrected.

Protan and deutan colour vision deficiency (CVD) were found in 1% and 8% of the males, respectively. One female student (0.7% of females) performed as a deutan.

Compared to similar studies in Asia and Australia (Dirani et al., 2009; French, Burlutsky, Mitchell, & Rose, 2013; Lee, Jee, Kwon, & Lee, 2013; Lin, Shih, Lee, Hung, & Hou, 1996; Qian et al., 2009), the prevalence of myopia is lower, and both hyperopia and CVD are higher. Uncorrected hyperopia has been reported to contribute to poorer academic performance (Williams, Latif, Hannington, & Watkins, 2005), and its prevalence among Norwegian students is of educational concern.

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Improving the health and education of a city: The Born in Bradford vision

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Abstract

Can perceptual-motor measures improve the health and education of a city? I will argue that objective measures of perceptual-motor (and cognitive-motor) function do have the potential to improve a city. Perceptual-motor impairments have a significant impact on a number of aspects of child development, with visual and motor deficits in low birthweight children predicting later cognitive and academic problems. Perceptual-motor impairment in the general population is recognised as a major risk factor for poor academic performance, anxiety, depression and other mental health problems. Moreover, perceptual-motor impairment is a predictor of physical activity and fitness, and increases the probability of physical health problems such as obesity and cardiovascular disease. It follows that it is imperative to identify and treat perceptual-motor deficits in children. In order to support my arguments I will present data on vision and motor function from the Born in Bradford (BiB) study: a unique prospective pregnancy and birth cohort involving 12,453 women experiencing 13,776 pregnancies. BiB was established to examine how multiple factors impact on development in deprived multi-ethnic populations, with the children tracked through life.

Acknowledgements

MMW acknowledges funding from the National Institute for Health Research (NIHR) Collaboration for Leadership in Applied Health Research and Care (CLARHC) implementation grant (Grant No. KRD/012/001/006)

Visual and Psychological Stress during Computer Work

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Abstract

Studies have shown associations between eyestrain and musculoskeletal pain in the neck and scapular area (Lie & Watten, 1987, 1994; Helland et al., 2008). In line with this, there are shown correlations between visual unfavorable conditions and stabilizing muscles in the neck and shoulder area during computer work (Richter, Banziger, & Forsman, 2011; Richter, Zetterlund, & Lundqvist, 2011; Zetterberg, Forsman, & Richter, 2013). In a previous study, we showed that exposure to visual stress introduced as glare during reading on a computer screen affected both eye-related symptom development, eye muscles (orbicularis oculi) and head-stabilizing musculature (trapezius), compared to reading under appropriate lighting conditions –[paper submitted]. To further elucidate how glare affects symptoms, orbicularis oculi and trapezius, we wanted to examine these muscles during both psychological stress and visual stress (glare). Psychological stress is previously shown to increase trapezius muscle blood flow and muscle activity (Larsson, Larsson, Zhang, Cai, & Oberg, 1995) (Lundberg et al., 2002).

The present study investigated how visual stress, introduced as glare, and psychological stress influenced m. orbicularis oculi, m. trapezius, subjective affective states and symptoms during computer work.

Twenty-four healthy, young women (22 $\pm$ 2 years, mean $\pm$ SD) with normal binocular vision were included in the study.

All testing was carried out at the same optimized computer work place. Four different computer work sessions with different stress exposures were performed:

1. Low stress, LS,
2. Visual stress, VS (glare),
3. Psychological stress, PS and
4. Visual and psychological stress, VPS.

We used a counterbalanced design. The assignment was proofreading using a regular mouse as input device. Each session lasted for 10 minutes with approximately 15 minutes breaks. Muscle activity and muscle blood flow in dominant m. trapezius and muscle blood flow in m. orbicularis oculi (dominant eye) were registered continuously during computer work and rest recordings. Muscle blood flow and muscle activity were measured using photoplethysmography (PPG) and electromyography (EMG), respectively.

Sitting posture was continuously registered using inclinometers. Productivity, accuracy, blood pressure and heart rate were also registered. Subjective symptoms and psychological stress indicators, such as affective states, were recorded using VAS-scales.

Overall differences between the conditions and overall temporal changes were tested by repeated measures ANOVA. If significance was indicated, differences at each time point were tested by Paired-Samples *t*-test or Independent-samples *t*-test. Pearson correlation was used to examine correlations between different variables. A statistical difference was accepted at $p<0.05$ (two-tailed). Statistical analysis was performed in PASW Statistics 17.0 (SPSS Inc., US).

Preliminary results shows that the subjects felt significantly more uncomfortable during the two glare conditions (VS and VPS), than during computer work with low stress exposure. They also felt more uncomfortable during the condition with both visual and psychological stress, compared to having only psychological stress exposure.

The subjects experienced the ambient lighting as significantly more uncomfortable during both VS and VPS, compared to the two conditions with appropriate lighting, LS and PS. Interestingly, they also perceived ambient lighting as significantly more uncomfortable when exposed to both psychological stress and glare, compared to only glare exposure. Preliminary results also show significantly overall increased trapezius muscle activity when exposed to glare and psychological stress simultaneously, compared to the low stress condition.

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Acknowledgements

The study was supported by a grant from the Norwegian Extra Foundation for Health and Rehabilitation / Spine Association Norway

Assessing fitness to drive in stroke survivors

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Abstract

Stroke survivors with visual field deficits are often banned from driving – restricting mobility and quality of life. However, some individuals with visual field deficits may be able to adapt through compensatory eye-movement strategies (Coeckelbergh, Brouwer, Cornelissen, Wolffelaar, & Kooijman, 2002). Thus, fitness to drive after a stroke might be best assessed in terms of perceptual-motor capability rather than extent of visual field loss. It is therefore important to find readily deployed tests that can inform assessment of driving-related visual-motor function. A powerful approach is to combine clinical approaches with experimental techniques. Our team has collected data from a number of stroke survivors using standard clinical assessments taken together with novel experimental measures. The experimental tasks recorded steering and eye-movement behaviours. We found that performance on a hazard detection task could be somewhat predicted by identifying 'adequately' or 'inadequately' compensated individuals on a simple computerised visual search task (Smith et al., 2015). This early result provides support for the idea that perceptual-motor measurements might be useful when predicting driving-related function. This method may identify routes for targeted rehabilitation to improve mobility in stroke survivors.

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Acknowledgements

Remedi

Happy living in darkness – even happier living in the light. Older Norwegians experience improved ability to perform activities of daily living and quality of life with improved indoor lighting

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Abstract

Lighting is identified as a significant environmental attribute promoting visual, physical and mental health for older people, factors contributing to enable older people to remain living at home. Due to normal visual age-changes, older people need more light, but increasing indoor lighting levels to compensate for this receives little attention. Thus, this intervention study investigated how improved indoor lighting levels affected the ability to perform ADL and the quality of life in older people living at home. Based on measured indoor lighting levels in the homes of 114 75-year olds (Eilertsen, Horgen, Kvikstad, & Falkenberg, 2015), 30 co-habitant and single persons participated in a four-month intervention in the dark winter period. The intervention optimized lighting levels in the living room by providing lamps and a basic control system with three preset levels (normal, medium, low). Participants adjusted the light levels and kept a diary. A questionnaire measured self-reported visual and general health (SF-36) and the ability to perform ADL in regards to lighting before and after the intervention period. Participants were happy with the improved lighting and reported improved quality of life. They used higher light levels, which increased comfort and wellbeing. They now appreciated being able to perform visually demanding tasks even in the evening, and acknowledged that avoidance of these tasks was mainly due to poor lighting. They valued the lighting control system, especially that it was easy to use, had preset levels and included their own lamps. Good vision is essential in maintaining healthy ageing at home and require adequate lighting. However, the knowledge and awareness of this is limited. The intervention showed that improved lighting can easily be achieved with a basic lighting control system. This suggests that improved quality of light can improve quality of life.

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Acknowledgements

The Norwegian State Housing Bank, Arena Health Innovation, Elko, Mulitconsult & ECT

Innovative strategies for treating stem cell deficiency of the ocular surface

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Abstract

Regulatory demands for transplantation of cultured cells for treating stem cell disorders have increased over the years, resulting in high costs. Therefore, any strategy to circumvent the use of culture facilities without compromising clinical results or safety is appealing. Whether cells should be transplanted directly onto the eye or cultured ex vivo has become a question of particular interest over the past few years. Recently, simple limbal epithelial transplantation (SLET), in which tiny limbal epithelial explants are cultured directly onto an amniotic membrane attached to the cornea, was described. Based on promising short-term clinical results of SLET, other cell types should be explored in treating total bilateral LSCD using a similar approach as in SLET. The main rationale for harvesting non-ocular tissue is: 1) no risk of inducing limbal stem cell deficiency in the donor eye, and 2) the possibility of treating bilateral limbal stem cell deficiency with autologous tissue, thus circumventing the need for long-term immunosuppression. Simple oral mucosal epithelial transplantation (SOMET) and simple epidermal transplantation (SET) may both prove viable future approaches as both laboratory cultured oral mucosal cells and epidermal cells have proved useful in treating limbal stem cell deficiency. Direct transplantation of oral mucosal sheets has already been performed with good results. However, this technique leaves a considerably larger wound in the mouth compared to what is required for ex vivo cultured oral mucosal cells or SOMET. A potential disadvantage of SOMET is that the mouth has a larger range of pathogens than the ocular surface, possibly increasing the risk of introducing infections in SOMET. Using SET there is no additional risk of infections compared to SLET. In conclusion, simple epithelial transplantation currently appears to be the most promising choice for a future, innovative cell based treatment of limbal stem cell deficiency due to extreme ease of access coupled with the high success rate in animal studies following transplantation of laboratory cultured epidermal cells.

Retinal structure over small hard macular drusen

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Abstract

Drusen are small extracellular deposits that form under the

retinal pigment epithelium, and are characteristic of aging and age-related macular degeneration (AMD). The presence of a few small hard drusen is not considered to be of clinical importance, and can also be found in young adults (Munch et al., 2007; Silvestri et al., 2012). However, it is implied that even eyes with very small clusters of small hard macular drusen are at greater risk of developing larger areas with small hard drusen than eyes without drusen (Klein et al., 2015).

Numerous small hard drusen (>8 per eye) in the macula have been found to increase the risk of developing soft drusen and pigment abnormalities later in life, which are, in turn, associated with progression to more advanced AMD (Klein et al., 2007; Klein, Klein, Tomany, Mauer, & Huang, 2002). It is discussed whether a large area of small hard drusen defines an even earlier AMD phenotype. Little is known about drusen-related morphologic characteristics and long-term significance of small hard macular drusen in young adults without AMD.

The purpose of this study was to examine retinal structure over small hard macular drusen in healthy eyes by high resolution in-vivo imaging of the retina.

Color fundus photographs were used to identify small hard macular drusen. Eyes with one or more drusen within 10 degrees from the foveal centre, were examined with the Heidelberg Spectralis OCT and the Kongsberg Adaptive Optics Ophthalmoscope II. Drusen morphology was described, and retinal layers were analyzed by calculating longitudinal reflectivity profiles. Analysis of cone density and mosaic regularity was performed in adaptive optics (AO) images over and around drusen using custom software.

AO imaging revealed early subclinical changes of the photoreceptor mosaic in terms of altered retinal reflectivity over small hard drusen. The results are discussed in comparison to findings from previous in-vivo and histological studies.

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Effects of contact lens use in a cohort of dry eye disease patients

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Abstract

To assess possible adverse effects of contact lens use in a cohort of dry eye disease (DED) patients.

DED patients either with or without contact lens use were consecutively included in the study. All patients received an extensive ophthalmological work-up and completed the Ocular surface disease index (OSDI) questionnaire.

Three hundred and thirteen patients with DED of different etiologies were included. 8% (24 patients) of the cohort wore contact lenses, whereof 22 patients wore soft contact lenses and the 2 wore rigid contact lenses. After controlling for gender, age and the number of systemic prescription drugs used, patients wearing contact lenses had a lower OSDI score (9.9 ± 8.7) than non-contact lens wearers (14.5 ± 8.1) ($p < 0.05$). Significant reduction (53.8 ± 1.8) of corneal sensitivity measured with the Cochet-Bonnet esthesiometer was observed in patients wearing rigid contact lenses compared to soft contact lens users (60.0 ± 0.0) and those not using contact lenses (59.2 ± 3.1) ($p < 0.05$). No other differences between contact and non-contact lens wearers could be observed in our cohort.

Contact lens wearers have a lower OSDI score than non-contact lens wearers. Unexpectedly, contact lens weraers as a group (including both soft and rigid contact lenses) did not show any other differences compared to non contact lens wearers.

Visual status when children start school in Norway

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Abstract

There is a need for information on visual status of children in Norway, and the purpose of this study was to investigate the extent, variety and significance of visual problems in children at an age when they start formal schooling. After the age of 4-5 years, there is no official vision screening of Norwegian children and the responsibility of vision and eye health is the sole responsibility of the parents. We investigated visual status in 350 children during their first two years of formal education. The children were recruited and examined in four different schools in Norway. An extensive battery of tests on accommodation and binocular vision was included and a considerable number of children were found to have visual problems at near: More than 40% had problems in at

least one category of binocular vision (accommodation, heterophoria, vergence, fusion or eye movements). In all 13% had previously undetected refractive errors. Hyperopia was the most common refractive error (28%), whereas myopia was literally non-existent in this age group. 56% of those already wearing an optical correction were found to have an additional binocular problem, whereas only 14% of those with a binocular problem had a significant refractive error. The protocol included an extensive questionnaire for history, symptoms and environmental factors. It was found that 28% had a combination of high symptom score and a visual problem, and hence considered in need of treatment. In general, there seems to be an ever-increasing demand for near work, with an increasing use of digital devices at a decreasing viewing distance for longer periods of time. When we find that a substantial number of children have visual problems, in particular at near, when they start school, this is of concern. It is likely that a lot of children have to go through childhood and formal education with visual deficits in the accommodation/convergence and binocular vision domain that are not detected. It remains unexplored to what extent a child who is hypermetropic and/or has near vision problems have the visual stamina to do well at school, and how this affects learning and their ability to complete formal education at a satisfactory level.

Vision rehabilitation of older people in Norwegian public health service

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Abstract

As we age, the prevalence of ocular disease and visual impairment increases, and so does the need for vision rehabilitation. Vision rehabilitation includes the assessment of visual function and visual needs, prescription of low vision devices, instruction in the use of low vision devices, training in effective use of residual vision, as well as patient information and support. The aim of this study was to describe vision rehabilitation of older people ($\geq$ 65 years) within the public health service in Norway. The study had a cross-sectional design. The target population was optometrists working in the public health services ($n = 50$) in Norway. The sample populations were optometrist working in vision rehabilitation services ($n = 44$) and ten of their encountering patients. The optometrists filled in a questionnaire and a practice registration form for ten consecutive patients. The questionnaire included questions about the optometrist, the low vision examination and the framework for the vision rehabilitation service. The practice registration form recorded information about patient age, gender, ocular diagnosis, presenting and best corrected visual acuity, low vision devices and lighting, patient information, instruction and training. All patients received information about the study and gave informed consent to the data collection. Data collection took place between October 2013 and February 2014. The Norwegian Social Science Data Services were notified before commencement of the study. The study was not subject to evaluation and approval by the Regional Committee for Medical Research Ethics. In all, 30 optometrists (68%) responded to the questionnaire, and of these 20 (45%) returned the practice registration form, including data from 95 consultations with older people with vision loss. The majority of the patients (68%) were 80 years or older; 67% were female. The primary cause of visual impairment (76%) was age-related macular degeneration. Seventeen patients (18%) were blind (visual acuity $< 6/60$) and 45 patients (48%) had moderate or severe visual impairment ($6/60 <$ visual acuity $< 6/18$). Thirty-one patients (33%) had only mild or no visual impairment (visual acuity $> 6/18$). In all, 23 patients (24%) achieved improved visual acuity with best optical correction, nine of them by one category or more on the WHO's classification of visual impairment (WHO, 1992). The most frequently prescribed low vision devices for near vision were hand magnifiers with and without illumination and CCTVs. For distance vision, the most frequently prescribed devices were filters and tinted lenses. The study shows that optometrists have an important role in vision rehabilitation of older people. A number of the patients attending public vision rehabilitation services do not have appropriate habitual vision correction; with adequate optical correction some these patients may have only mild or no visual impairment. This indicates a potential to involve Norwegian optometric practices as the first step for vision rehabilitation of older people.

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The effects of culture parameters on ex vivo expansion of oral mucosal cells

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Abstract

The oral mucosal epithelium has substantial potential for use in regenerative medicine, including the treatment of ocular surface disease. The rationale for using oral mucosal cells is the possibility of treating bilateral ocular surface stem cell disease without the use of immunosuppression. The present project investigated four harvesting sites for oral mucosa and four culture media for these cells. The four harvesting sites were: buccal mucosa (BM), hard palate (HP), lower lip (LL), and transition zone of the lower lip (TZ) of Sprague-Dawley rats. Explants were grown in four culture media for six days and 13 days (LL and TZ) to generate oral mucosal epithelial transplants. The media were 1) RPMI 1640 with 10% heat- inactivated fetal bovine serum (FBS), 2 mM L-glutamine, and 50 IU/mL penicillin-streptomycin; 2) EpiLife with epidermal growth supplement; 3) oral keratinocyte media (OKM) with oral keratinocyte growth factor; and 4) DMEM and Ham 12 (1:1 mixture) supplemented with 10% FBS, 5 μg/mL insulin, 0.1 nmol/L cholera toxin, 10 ng/mL human recombinant epidermal growth factor, and 50 IU/mL penicillin–streptomycin. Inverted light microscopy was used for outgrowth measurements with ImageJ. Immunofluorescence microscopy was used for phenotype characterization using anti-

bodies against proliferating cell nuclear antigen (PCNA) and neural growth factor P75 (NGF P75). Stemness was assayed by colony-forming efficiency assay. We found that DMEM and RPMI yielded higher explant outgrowth than OKM and Epilife. Using DMEM and RPMI, fold growth was superior in transplants started from LL explants (36.43 $\pm$ 7.42 and 32.34 $\pm$ 12.22, respectively) compared to the explants from HP (7.46 $\pm$ 0.69 and 10.14 $\pm$ 1.14, respectively), BM (11.15 $\pm$ 2.94 and 22.40 $\pm$ 8.45, respectively) and TZ (19 $\pm$ 3 and 15 $\pm$ 4.02, respectively) (p<0.05; N=4-11). The percentage of PCNA+ (proliferating) cells was lower in cells cultured in RPMI compared to cells grown in DMEM. Expression of stem cell marker Bmi-1 was detected only in the cells cultured in DMEM. PanCK and CK4 expression did not vary depending on the culture media or the location. Cells from TZ yielded highest colony forming efficiency (0.057% $\pm$ 0.006%) followed by BM (0.004% $\pm$ 0.004%), HP (0.017% $\pm$ 0.004%) and LP (0.003% $\pm$ 0.002%) (p<0.05; N=2-6) in DMEM media. RPMI media did not give rise to colonies at all. The transition zone of the lower lip, which showed the highest colony forming ability, may be most effective in treating limbal stem cell deficiency.

The Potential Effect of Continuing Professional Development on Optometrists' Diagnostic Sensitivity and Management of Diabetic Retinopathy

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Abstract

Diabetic retinopathy develops gradually and symptoms may not occur before visual loss is irreversible. Regular eye examination and timely treatment reduce vision loss. The aim of this study is to evaluate the effect of a web-based Continuing Professional Development (CDP) programme on optometrists' diagnostic sensitivity for detection and management of diabetic retinopathy. The study had an interventional, cross-sectional design. The study population was Norwegian optometrists working in private practice. The intervention consisted of a training programme, including a study guide, three digital learning resources, two papers and three web-based "Visual Identification and Management of Ocular Conditions" assessments (VIMOC) related to evaluation and management of diabetic retinopathy. The purpose of the VIMOC assessment was to evaluate diagnostic sensitivity (1) before and (2) after training and (3) provide individual feedback to the optometrists on their performance. The VIMOC included 14 retinal images. The optometrists had to assess the manifestations of diabetic retinopathy, identify clinical signs of diabetic retinopathy, grade the severity of diabetic retinopathy and state how they would manage the patient. To reduce the possibility of false high specificity, half of the retinal images had no diabetic retinopathy. Data collection took place February to March 2015. The Norwegian Social Science Data Services (NSD) approved the study. In all 18 optometrists completed the study, 12 were women. Undilated fundus photography was the preferred method for retinal examination (72%). Only 12 of the 16 optometrists (75%) with the rights to use diagnostic drugs performed dilated retinal examination. Nine optometrists (50%) reported that patient management and decision to refer patients depended upon the degree of diabetic retinopathy and whether the patient was under the care of an ophthalmologist. The optometrists' diagnostic sensitivity improved significantly by completing the CPD programme. Before training the sensitivity for detection of diabetic retinopathy was 71% ($\pm$20), whereas after training the sensitivity improved to 86% ($\pm$ 13), t-test p?0.011. There was no significant change in specificity. The grading sensitivity also significantly improve from 18% ($\pm$12) to 45% ($\pm$13), t-test p<0.001. Respectively, two and six optometrists met the screening standard, sensitivity of at least 80% and specificity of at least 95% (BritishDiabeticAssociation, 1997), before and after training. In general, the optometrists referred the patient when they found diabetic retinopathy. In terms of false negatives, the optometrists would have referred in 5 of 36 cases before training and 2 of 18 cases after training. In terms of false positives, 17 and 34 respectively of 252 cases would have been unnecessarily referred before and after the implementation and completion of the training programme. A CPD programme targeting detection and management of diabetic retinopathy significantly improves optometrists' diagnostic sensitivity. Future studies should assess whether implementation of clinical workshops, case discussions and use of grading scales tools can further improve diagnostic quality to obtain the required screening standard for diabetic retinopathy.

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Storage of Cultured Skin Cell Sheets for Treatment of Limbal Stem Cell Deficiency

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Abstract

The use of an alternative autologous tissue source for culture of epithelial sheets offers hope for treatment of bilateral limbal stem cell deficiency (LSCD). Preliminary animal studies have shown that cultured epidermal cell sheets (CES) have potential to treat this widespread and painful disease (Yang et al., 2008). The study aim was to develop a method for one-week storage of CES for their international or regional distribution and use in regenerative medicine. As well as maintenance of viability during storage, preservation of undifferentiated phenotype (Rama et al., 2010) is an important criterion contributing to successful transplant. Our preliminary results suggest that storage at above freezing temperatures may result in superior preservation of these important characteristics. Furthermore, this may be developed as a convenient system for storage compared to cryopreservation that demands specialized equipment.

The effect of storage temperatures 4°C, 8°C, 12°C, 16°C, and 24°C on CES was evaluated. Analyses included viability using calcein, reactive oxygen species (ROS) by dihydroethidium (DHE), membrane damage by lactate dehydrogenase leakage, mitochondrial DNA integrity by real-time polymerase chain reaction, morphology by light and transmission electron microscopy, and phenotype by immunocytochemistry.

Morphology and phenotype analyses revealed that differentiation progressed with temperature. Compared to control non-stored cells, ABCG2 expression increased at 8°C, 12°C, and 16°C, whereas accumulation of the ROS superoxide coincided with reduced ABCG2 expression, increased differentiation, and increased membrane and mitochondrial DNA damage at 24°C. P63, C/EBPδ, and K10 fluorescence combined with morphology observations, supported retention of undifferentiated cell phenotype at 12°C, transition to differentiation at 16°C, and increased differentiation at 24°C.

In conclusion, 12°C was the only temperature where viability and undifferentiated cell character were similar to control, and may be an ideal temperature for CES storage and transportation.

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Acknowledgements

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Timing behaviour in children and its relationship to mathematics

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Abstract

Theories of embodied cognition suggest that the ability of humans to perform abstract mathematics is grounded in sensorimotor interactions with the environment. Consistent with this viewpoint is the finding that motor skills can predict children's mathematics attainment. Interceptive timing is a fundamental skill involved in many sensorimotor tasks, yet it is not understood how this ability develops in children. It may be that understanding how objects move through space and time underpins abstract representations of quantity and time. To test this hypothesis we took objective measures of interceptive timing abilities in 440 primary school children (aged 4-12). Children were instructed to hit 54 virtual moving targets that varied in size and speed using a 1-DoF manipulandum to control an onscreen bat. Using Bayesian estimation techniques we found that interceptive timing uniquely predicted mathematics attainment even after controlling for general motor skills and age. For every 5 targets hit the probability of achieving a mathematics attainment score above the school year group average increased by 4%. This finding is consistent with theories that suggest sensorimotor processes are fundamental to mathematics abilities.

Optometrists' and optometry students' communication self-efficacy: the COMHOME study

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Abstract

Optometry is the largest profession in vision care and most optometrists provide their services within a commercial setting. Even though communication between the patient and the health care practitioner is important, communication skills training is not part of the optometry curriculum and it is unknown how confident optometrists feel about their communications skills. The main objective of this study was to explore optometry students' and optometrists' communication self-efficacy. The sample consisted of bachelor students in optometry and qualified optometrists in the masters' degree programme at Buskerud and Vestfold University College. Self-efficacy in communication, empathy and mindfulness were assessed by using three questionnaires: Ammentorp's "Clear-cut communication with patients" (CSE), Jefferson Empathy Scale (JES) and Langer 14 items mindfulness scale (LMS-14) (Hafskjold et al., 2015). The study was approved by the Norwegian Social Science Data Services. Fifty-four students participated. Thirty-three (61%) were qualified optometrists; the majority (85%) worked part- or full-time in optometric practice. The average communication self-efficacy score was 6.9 (95% CI 6.6 to 7.2) on a 10-point Likert scale where 10 was "very sure to succeed". There were no differences in scores for the three phases of the medical dialogue; building a relationship (CSE item 13, 14, 16 and 17), assessment (CSE item 11-12 and 15) and collaboration for management (CSE item 18-21). Scores were 7.3 (95% CI 7.0 to 7.6), 7.0 (95% CI 6.7 to 7.3) and 7.1 (95% CI 6.7 to 7.4) respectively. There were also no significant differences in the average scores for communication or in the total scores for empathy and mindfulness between optometry students and optometrists. However, the scores for impact of emotions in treatment and care (JES item 1 and 14), were significantly different; the qualified optometrists agreed more frequently with the impact of emotions on treatment and care than the optometry students did. There seems to be potential for improving optometrists' self-confidence in their own communication competence. However, communication in optometric settings needs further exploration. This study contributes to the knowledge of communication in optometry and health care in a commercial setting.

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Optical Errors and Visual Evaluation in Periphery

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Abstract
Our visual system is optimized for central vision. The peripheral visual field has large optical errors dominated by astigmatism and coma. In addition, neural sampling also deteriorates in the periphery. However, peripheral visual evaluations are important in many aspects of vision care and research. The main examples are myopia research and visual rehabilitation in central visual field loss. In natural viewing conditions, peripheral vision is exposed to existing optical errors. In some cases, peripheral vision is exposed to additional induced blur; for example, via spectacle corrections that aim to correct for central vision. We investigated the effects of exposure to blur and subsequent adaptation on visual performance. Our results disclosed that visual performance after a short exposure to optical bur is dependent on the lateral extent of the adaptation stimulus. The influence of peripheral stimuli on the foveal adaptational effect is of special interest for myopia research.

In order to perform accurate visual evaluations in the periphery, appropriate visual stimulus and correction must be used. High contrast resolution in the periphery is neurally limited and is not affected by optical errors, whereas detection is affected by optical errors. Furthermore, peripheral resolution acuity is known to be dependent on the orientation of the stimuli. It is uncertain if such a meridional effect also exists for peripheral detection tasks, as they are affected by optical errors. Knowledge of the quantitative differences in acuity for different grating orientations is crucial for choosing the appropriate stimuli for evaluations of peripheral for resolution and detection tasks. Our measurements on peripheral resolution and detection with optical correction showed that gratings parallel to the visual field meridian had better threshold compared to the perpendicular gratings, whereas the two oblique gratings had similar thresholds for both resolution and detection tasks. The parallel and perpendicular grating acuity difference for resolution and detection tasks were 0.16 and 0.11 log acuity respectively. The smaller meridional effect for detection may be due to the correction of peripheral optical errors. The presence of meridional effect even after correction of peripheral optical errors suggests an underlying neural origin. Based on our results, we recommend using two oblique grating orientations for the evaluation of peripheral vision.

Acknowledgements
This research was supported by the European Commission (OpAL, an Initial Training Network-PITN-GA-2010-264605) and the Swedish Research Council (621-2011-4094)

A new Vision for high-speed steering

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Abstract
A failure to respond appropriately to changes in upcoming steering requirements can be catastrophic in high speed driving. Drivers rapidly sample the visual information needed for 'online control' through active gaze, but which perceptual inputs are used is unknown. Influential models of driving have captured many steering behaviours assuming that the visual system uses road edge information alone. These models often identify separate "near" and "far" edge components, used for compensatory and anticipatory control, respectively. But this approach is not consistent with evidence that the human visual system uses multiple inputs to maintain robust control of steering (Wilkie & Wann, 2002). Moreover, it appears that optic flow information is used even when road edges are visible (Kountouriotis et al., 2013). We have conducted a series of experiments examining the contribution of optic flow and road edges to compensatory and anticipatory control. Optic flow was systematically manipulated independently of road edges so that use of flow would lead to predictable understeering or oversteering. Crucially, the use of flow depended on the availability of far or near road edge information. It appears that the visual-motor system not only uses multiple inputs, but weights the information depending on the nature of the control task. These insights demonstrate that models describing how the visual-motor system controls high-speed steering must consider weighted cue combination.

Acknowledgements
Emma & Leslie Reid Scholarship

The Eyesi Indirect augmented reality BIO-simulator is an effective teaching tool for optometry students

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Abstract
Binocular indirect ophthalmoscopy (BIO) is an important part of an optometric eye examination. The technique demands practice, which is made more complicated by considerable light exposure and the need for pupil dilation. A simulator could allow students to focus on the technique without being concerned with these incidental complications. The aim of the study was to evaluate the effect of teaching binocular indirect ophthalmoscopy (BIO) using the *Eyesi* (VRmagic) augmented reality simulator. As part of a taught course, forty final year Norwegian optometry students were given one 90-min introductory BIO session before having a 5-min test performing BIO on a healthy person. They were instructed to examine as much as possible of the retina within the time frame, with emphasis on a structured examination procedure, and to report ocular findings. Two experienced optometry supervisors evaluated the students using teaching mirrors, and students were assessed on image quality, structured examination procedure and identification of findings. Further, the students were randomly divided into two groups, where one was given conventional clinical supervision (Group A), while the other was required to follow a set simulator program (Group B). The students were retested after 3 weeks, before swapping training programs and tested a third time 3 weeks later. There were no statistically significant differences between the groups at either of the tests for image

quality (mixed design ANOVA, $p > 0.05$), structured examination procedure and identification of findings (Pearson's Chi-square, all $p > 0.05$). There was a statistically significant increase in performance over time for both groups, as expected. All assessment criteria were significantly improved between each test ($p < 0.05$), with the exception of no significant change in identification of findings for Group A between test 2 and 3 ($p = 0.06$). One may speculate that this might be due to the nature of the chosen simulator programs, where the focus is on locating geometrical symbols and not identifying ocular findings. The results show that neither group was disadvantaged by using the simulator, suggesting it is an effective teaching tool. While such tools cannot substitute the patient communication and handling skills that can be gained from training on real patients, they do offer valuable practise time without the inconvenience of repeated pupillary dilation.

doi:10.5384/SJOVS.vol8i2p1 - ISSN: 1891-0890