

## Kongsberg Vision Meeting 2016: Abstracts

Kongsberg Vision Meeting was arranged at the University College of Southeast Norway in Kongsberg for the ninth time on November 28–29, 2016. The meeting was organised as a two-day meeting with a research day and a clinical continuing education day. Rigmor C. Baraas, Ellen Svarverud, Per O. Lundmark, Helle K. Falkenberg and Vibeke Sundling organised the two-day meeting. The theme this year was vision and driving. Keynote speakers for the research day were Thomas J. van den Berg from Netherlands Institute of Neuroscience, Royal Academy, Amsterdam, The Netherlands; Joanne Wood from School of Optometry and Vision Science and Institute of Health and Biomedical Innovation, Queensland University of Technology, Australia and Richard Wilkie from the School of Psychology, University of Leeds, UK. The invited keynote speakers for the clinical day were Ole Bjørn Herland from the Norwegian Directorate of Health as well as van den Berg and Wood. The abstract from Herland is presented first followed by other invited and contributed talks as well as posters, presented in the order they were given.

Received November 1, 2016, Accepted November 10, 2016.

### Assessing fitness to drive: New medical requirements of visual functions

Ole Bjørn Herland

Norwegian Directorate of Health, Norwegian Directorate of Health, Universitetsgata 2, Oslo, 0164, Norway

[ole.bjorn.herland@helsedir.no](mailto:ole.bjorn.herland@helsedir.no)

#### Abstract

Driving is a complicated process where vision is the most important channel of information for decision making. The Norwegian Directorate of Health introduced new medical requirements for obtaining and retaining a driving licence on 1<sup>st</sup> October 2016. The objectives for developing new requirements were: (i) to implement EU-directives, (ii) to have evidence-based road safety requirements, (iii) to make sure that the general practitioner was the one who should be best informed about the applicant's overall health condition, (iv) to make sure the requirements were clearly formulated and understandable to the public.

When applying for a Group 1 driving licence (mopeds, motorcycles and motor vehicles) the applicant is required to submit a health statement to the Norwegian Public Roads Administration (Statens vegvesen). If this statement reveals any health issue that might pose a limitation to the person's visual function, then he/she must obtain a statement from either an optometrist or an ophthalmologist documenting their visual status. Optometrists are given a wider responsibility regarding evaluation of vision and visual functions than they had previously.

The new requirements state that Group 1 licence applicants must have Snellen visual acuity of at least 0.5 (6/12) binocularly or in one eye alone (where there is complete loss of vision in one eye). For Group 2 (large goods vehicles) licence applicants, visual acuity must be at least 0.8 (6/7.5) in one eye and 0.1 (6/60) in the other. Binocular visual field should be full for at least 120 degrees horizontally and 20 degrees vertically (upwards and downwards) for Group 1, compared with 160 degrees and 30 degrees for Group 2. No blind spots should be detected within the central 20 or 30 degrees of the visual field, respectively. For Group 2 applicants no reduction in contrast sensitivity is permitted. It is recommended that normal values be achieved with the Pelli Robson contrast sensitivity chart or an equivalent test. General visual

function shall be evaluated by an optometrist or ophthalmologist in cases where there has been a recent reduction or loss of vision in one eye. Compensatory adjustments of double vision shall be evaluated for Group 1 applicants. Vision in one eye only is not acceptable for Group 2 applicants. Applicants who have reduced night vision or are dazzled by sudden changes in lighting conditions shall be evaluated with regards to whether their condition could impede road safety. In Norway, all new driving licence applicants must show competence in driving through tunnels.

If double vision occurs, or there is significant loss of vision in one eye, an additional driving test should be undertaken for Group 1 applicants. If an ophthalmologist confirms good general visual function, an additional driving test can be undertaken also for Group 2 applicants. Minor exemptions regarding either visual acuity or visual fields may be allowed for Group 1 applicants if an ophthalmologist approves a driving licence after a driving test is held. The Norwegian Public Roads Administration are responsible for arranging all driving tests.

If there is a suspicion that a progressive disease might affect visual function (except cataract), the condition shall be evaluated with necessary follow-up by an ophthalmologist.

### Straylight; the functional effect of light scattering. Basics and applications

Thomas J. van den Berg

Straylight Lab, Netherlands Institute for Neuroscience, Royal Academy, Meibergdreef 47, Amsterdam, 1105 BA, Netherlands

[t.j.vandenberg@nin.knaw.nl](mailto:t.j.vandenberg@nin.knaw.nl)

#### Abstract

As light enters the pupil of the eye to form an image on the retina, part of that light is scattered in different structures, such as the cornea and crystalline lens. This causes a veil of light on top of the more or less proper retinal image. Added to this veil is also light scattered back from the fundus, and light diffusely transmitted by the iris and exposed part of the sclera. The scattered light forms part of the functional point-spread-function, in particular its peripheral part. It results in the visual phenomenon of light perceived to radiate out from bright point light sources against a dark background. This perceived light spreading is called straylight, and is quantified by its equivalent luminance value. The straylight phenomenon causes blinding while driving at night, or against a low sun. The CIE has decided that straylight should be used as standard to quantify disability glare. Straylight increases with aging, and with different adverse conditions, including age related deteriorations such as cataract. The increase in light scattering from the crystalline lens derives from small particle scattering, i.e. particles of about wavelength size, that increase in number with aging and cataract formation. Other conditions, particularly corneal dystrophies, can also cause increased straylight effects. Straylight can be measured precisely based on the equivalent luminance concept using psychophysical techniques. The straylight value has been found to correspond in one-to-one fashion to optically defined light scatter. For routine clinical application, in particular for early functional cataract detection, we developed the special psychophysical technique of "compensation comparison". Scatter important for vision is forward scatter, whereas backscatter is more easily accessible, such as with the slit lamp. The relation with functional (forward) light scatter is weak though.

## Dark adaptation in normal and pathological vision

Hilde R. Pedersen, Jon V. B. Gjelle, Lene A. Hagen, Stuart J. Gilson, Rigmor C. Baraas\*

National Centre for Optics, Vision and Eye Care, Department of Optometry and Visual Science, Faculty of Health Science, University College of Southeast Norway, Kongsberg, 3616, Norway

\* Corresponding author: [rigmor.baraas@hbv.no](mailto:rigmor.baraas@hbv.no)

### Abstract

The purpose of this study was to examine variations in dark adaptation in normal and pathological vision. Problems with adaptation to lower light levels may affect visual performance while, for example, driving. The measure of dark adaptation quantifies the ability of rod and cone functions to recover after exposure to light.

Rod and cone mediated dark adaptation were measured with the DARKadaptometer (Roland Consult GmbH, Brandenburg, Germany) after a 5-minute bleaching with a bright white light (7000 cd/m<sup>2</sup>). The pupil was dilated with Tropicamide 0.5% prior to examination. Detection thresholds were measured for red (625 nm) and green (527 nm) 2° circular stimuli presented at 20° eccentricity (temporal) over a period of 35 minutes. The dark adaptation (DA) function was analysed by plotting log light intensity as a function of time and fitting a Loess-curve to the data.

The time to rod-cone break (TRCB) varied between 5 and 17 minutes for normal observers. TRCB showed a characteristic U function with age, where the youngest (10–19 years) had longer TRCB than those aged 20–49 years, with the TRCB increasing again for those aged 50 years and above.

TRCB for many of those with pathology was within the 95% CI of the age-matched normal subjects. Differences between DA functions in these individuals with pathology as compared with normal observers were related to reduced overall sensitivity for both the cone and rod parts of the DA function. If rod function is normal, TRCB and the shape of the curve tend to be within normal limits.

More data from the oldest age groups needs to be collected in order to assess the effect of age on rod and cone dark adaptation function to understand between-individual variability and when age-related changes might limit night vision.

## Understanding the Role of Vision in Driving: A Research Overview

Joanne M. Wood

School of Optometry and Vision Science, Queensland University of Technology, Victoria Park Rd, Kelvin Grove, Brisbane, Australia, 4159, Australia

[j.wood@qut.edu.au](mailto:j.wood@qut.edu.au)

### Abstract

It has been suggested that the major sensory input for driving is visual. Accordingly, most developed countries set visual standards for driving eligibility, with visual acuity and visual fields being the most prevalent vision standards set worldwide. However, there is considerable debate regarding which aspects of visual function are most important for safe driving, the level of visual function at which driving performance and safety are impaired and how different types of visual impairment impact upon driving performance.

The focus of my studies has been to address these questions using a range of experimental approaches including

measures of real-world driving performance on a closed circuit driving course and under on-road in-traffic conditions. Studies have included on-road investigations of older drivers with and without ocular conditions as well as closed road studies which have investigated the effects of age and simulated and true visual impairment under both day and night-time conditions. Innovative strategies have also been identified which have the capacity to improve the night-time visibility and hence safety of vulnerable road users, including pedestrians and cyclists.

This presentation will provide an overview of how visual function is linked with driving ability, based on the wider research literature, as well as providing a snapshot of some of my own studies conducted under closed and open road conditions. Emphasis will be placed on those studies that are relevant to assessing a patient's visual fitness to drive as well as providing relevant advice regarding the impact of common visual impairments on driving ability and safety.

### Acknowledgements

NHMRC, ARC

## Closed circuit driving performance in persons with quadrantanopia and hemianopia in Sweden

Karthikeyan Baskaran

Department of Medicine and Optometry, Linnaeus University, Smålandsgatan 26A, Kalmar, 39234, Sweden

[karthikeyan.baskaran@lnu.se](mailto:karthikeyan.baskaran@lnu.se)

### Abstract

In Sweden, persons with homonymous visual field defects (HVFDs) are not allowed to drive and usually their driving licences are revoked. Although earlier studies ([de Haan et al., 2014](#); [Elgin et al., 2010](#)) have shown that HVFDs do not necessarily impair practical fitness to drive, the Swedish transport agency does not allow them any on-road driving testing to prove their practical fitness to drive.

The aim of this study was to evaluate driving performance in participants with visual field defects after acquired brain injury in a closed circuit driving track.

Eleven former drivers with varying degrees of quadrantanopia and hemianopia after acquired brain damage were recruited for this study from the stroke rehabilitation department at Kalmar County Hospital. The median age of the participants was 55 years and their age ranged from 37 to 73 years. Driving performance was assessed by two experienced driving instructors. They graded the participants on a scale from 1 (major faults) to 5 (excellent) on the following five categories: manoeuvring the vehicle, risk assessment, traffic rules, visual scanning and situation awareness. The subject would pass the driving test only if they had scored 3 or more in each category. The subjects who passed the closed circuit driving track test were evaluated further with a driving simulator.

Five (45%) out of 11 participants passed the driving test and were adjudged as fit to drive. The remaining six (55%) participants failed in at least one category. Three failed in visual scanning, two failed in manoeuvring and one failed in both the aforementioned categories as well as risk assessment. Three subjects who passed the closed circuit driving track test were also evaluated in a driving simulator. Out of the three subjects, only one was able to complete and pass the

evaluation while the remaining two participants aborted the evaluation due to simulator sickness.

Homonymous visual field defects do not necessarily impair fitness to drive. Therefore, an on-road assessment of practical fitness to drive should be allowed in Sweden for this population in the near future. The decision on practical fitness to drive cannot be based solely on the presence of visual field defects. A rehabilitation program aimed at improving safe driving should be put into practice with an on-road driving training and assessment procedure. It should be developed and implemented by experienced traffic inspectors as a complementary part of the decision to either issue or revoke a driving licence for this population.

### References

de Haan, G. A., Melis-Dankers, B. J., Brouwer, W. H., Bredewoud, R. A., Tucha, O., & Heutink, J. a. (2014). Car driving performance in hemianopia: an on-road driving study. *Invest Ophthalmol Vis Sci*, *55*, 6482–6489.

Elgin, J., McGwin, G., Wood, J. M., Vaphiades, M. S., Braswell, R. A., DeCarlo, D. K., ... Owsley, C. (2010). Evaluation of on-road driving in people with hemianopia and quadrantanopia. *Am J Occup Ther*, *64*, 268–278.

### Acknowledgements

Arvsfonden

## Looking to the future of visual assessment and driving: using simulation to measure eye-movements and vision when steering

Richard Wilkie<sup>1\*</sup>, Matthew Smith<sup>2</sup>, Callum Mole<sup>1</sup>, Bryony Maw<sup>1</sup>, Georgios Kountouriotis<sup>3</sup>, Catherine Chisholm<sup>4</sup>

<sup>1</sup> Perception, Action & Cognition Laboratory, School of Psychology, University of Leeds, Leeds, LS2 9JT, UK

<sup>2</sup> Perception, Action & Cognition Laboratory, Major Trauma Rehabilitation, Leeds Teaching Hospitals, Leeds, UK

<sup>3</sup> Perception, Action & Cognition Laboratory, Institute of Transport Studies, University of Leeds, Leeds, LS2 9JT, UK

<sup>4</sup> Bradford School of Optometry and Vision Sciences, University of Bradford, Bradford, UK

\* Corresponding author: [r.m.wilkie@leeds.ac.uk](mailto:r.m.wilkie@leeds.ac.uk)

### Abstract

Human performance of skilled actions requires a tight coupling between perceptual inputs and motoric outputs. When driving, human vision provides multiple inputs that are mediated through the active gaze fixation system, however, there are also additional cognitive capabilities that allow the driver to dynamically respond to the world and make predictions about the scene as well as the behaviour of other road users. Given the complexity of driving through a busy urban environment it should be no surprise that simple tests of visual acuity seem to have little explanatory power in terms of increased crash risk when driving. Despite this, fitness to drive is still often assessed using visual acuity, with poor scores leading to the driving licence being revoked. There are a number of issues with using simple tests of visual acuity to infer driving capability, including their lack of sensitivity and specificity: the tests will stop some individuals from driving who are actually able to compensate for their visual deficits (e.g. through use of eye-movements), and the tests will fail to identify individuals that actually do have difficulties driving (e.g. that have cognitive rather than visual problems).

An alternative approach to visual assessment is to use driving simulation to recreate conditions similar to those experienced when driving. These methods not only allow us to

evaluate the link between visual function and driving performance, but also to examine whether the core driving components are intact – e.g. collision detection and steering control. There are many exciting possibilities using simulation techniques to establish predictive relationships between routine visual testing and driving performance, ultimately aiming for better, more reliable assessment of fitness to drive (Smith et al., 2015).

### References

Smith, M., Mole, C. D., Kountouriotis, G. K., Chisholm, C., Bhakta, B., & Wilkie, R. M. (2015). Driving with Homonymous visual field loss: Does visual search performance predict hazard detection? *British Journal of Occupational Therapy*, *78*(2), 85–95. doi:10.1177/0308022614562786

### Acknowledgements

Remedi funded the Stroke research; MRC funded the older adult research; EPSRC funded the steering research

## Examining road safety by simulating driver-VRU interactions

Callum D. Mole<sup>\*</sup>, Richard Wilkie

Perception, Action & Cognition Laboratory, School of Psychology, University of Leeds, LEEDS, LS2 9JT, UK

\* Corresponding author: [c.d.mole@leeds.ac.uk](mailto:c.d.mole@leeds.ac.uk)

### Abstract

Safe driving in the real world requires the driver to perform multiple concurrent tasks, whilst also coping with unpredictable events. The driver is required to not only control the car along the desired route, but also obey the rules of the road whilst using windows and mirrors to keep track of potential emerging hazards from other road users (drivers, cyclists, or pedestrians). Capturing these interactions under controlled laboratory settings is difficult. Vast resources could be spent generating “immersive” and “realistic” environments, but the more “life-like” the experience, the more experimental control is lost.

Our recent project (funded by Transport for London) aimed to strike a balance between the competing requirements of real-world variety and experimental control, enabling us to examine under controlled conditions how cab vision characteristics affect HGV driver safety. A two-stage approach was adopted. First, a series of control experiments recording reaction times to targets presented at precise locations in the visual field were undertaken. Second, a simulation was created that dynamically responded to the driver over a continuous period of driving for  $\approx 20$  mins, allowing the examination of driver behaviour during optically controlled interactions with pedestrians and cyclists. Using these combined methods, we established, for the first time, a potential link between slower reaction times under some viewing conditions and a corresponding increase in likelihood of vulnerable road user collisions. This approach has exciting potential for examining road safety and readiness in drivers with visual deficits.

### Acknowledgements

Transport for London

## Correlation between clinical parameters from the right and left eyes of a Norwegian cohort of dry eye patients

Behzod Tashbayev,<sup>1\*</sup> Xiangjun Chen,<sup>1</sup> Sten Ræder,<sup>1</sup> Øygunn Aass Utheim,<sup>1</sup> Aleksandar Stojanovic,<sup>2</sup> Tor Paaske Utheim<sup>1</sup>

<sup>1</sup> The Norwegian Dry Eye Clinic, The Norwegian Dry Eye Clinic, Oslo, 0172, Norway

<sup>2</sup> SynsLaser Kirurgi, SynsLaser Kirurgi Oslo/Trømso, Oslo, Norway

\* Corresponding author: [bektashbayev@gmail.com](mailto:bektashbayev@gmail.com)

### Abstract

The purpose of this study was to investigate correlation in clinical parameters between both eyes in a Norwegian cohort of dry eye patients

A total of 1279 patients with different levels of dry eye disease with different aetiologies were included in the study. All patients received an extensive dry eye work-up regardless of disease characteristics. Intra-class correlation between the right and the left eyes was performed using two-way mixed model with absolute agreement type. Results are presented as mean, standard deviation, Intra-class Correlation Coefficient (ICC). *r* and *P* values of less than 0.001 were considered significant.

The mean age of participants in the study (*n* = 1279) was 52.14 ± 17.1 years (range: 9–91); there were 38% males and 62% females. Excellent correlation between right and left eyes was observed in dry eye severity level (*r* = 0.93), tear film break-up time (*r* = 0.92), ocular protection index (*r* = 0.921), tear meniscus height (*r* = 0.95) and meibum expressibility (*r* = 0.92). Very good correlation was seen in scores of Schirmer 1 test (*r* = 0.86), ocular surface staining (*r* = 0.81), corneal sensitivity (*r* = 0.82) and meibum quality (*r* = 0.88). Tear osmolarity levels did not show high coefficient of correlation (*r* = 0.53). All calculations were statistically significant, *p* < 0.001.

In dry eye disease there is high correlation between the right and the left eyes in all measured clinical parameters apart from tear osmolarity levels.

## Medium- to long-term results of corneal cross-linking for keratoconus using phototherapeutic keratectomy for epithelial removal and partial stromal ablation

Xiangjun Chen

SynsLaser Kirurgi/ Tørrøyneklivnikken, SynsLaser Kirurgi/ Tørrøyneklivnikken, Oslo, 0159, Norway

[chenxiangjun1101@gmail.com](mailto:chenxiangjun1101@gmail.com)

### Abstract

The purpose of this study was to evaluate the medium- to long-term outcomes of corneal collagen cross-linking in treatment of keratoconus using transepithelial phototherapeutic keratectomy (PTK-CXL) for epithelial removal and partial stromal ablation, with an aim to stabilize the cornea, reduce corneal irregularity, and improve corrected vision.

Retrospective analysis of 46 keratoconic eyes that underwent PTK-CXL. Corrected distance visual acuity (CDVA), manifest refraction, steep and flat simulated keratometry ( $K_{\max}$  and  $K_{\min}$ ), corneal irregularity index (IRI), corneal

higher order aberrations (HOAs), epithelial thickness profile, and corneal biomechanical characteristics were evaluated preoperatively and postoperatively.

At a mean follow-up time of 21.0 ± 7.6 (range, 10 to 43) months postoperatively, CDVA improved from 0.25 ± 0.24 to 0.18 ± 0.22 LogMAR (*p* = 0.002). CDVA remained unchanged in 32.6% (15 eyes), 56.5% (26 eyes) gained up to five Snellen lines of CDVA, whereas 4.3% (2 eyes), 4.3% (2 eyes), and 2.2% (1 eye) lost one, two, and four lines of CDVA, respectively. Postoperatively, flattening of  $K_{\max}$  from 50.58 ± 5.26 to 48.96 ± 4.00 D and  $K_{\min}$  from 45.80 ± 3.11 to 44.77 ± 2.63 D (*p* < 0.001), reduction of IRI from 49.7 ± 24.5 to 43.4 ± 21.4 μm (*p* = 0.002), decrease of root mean square HOAs (at 5 mm diameter) from 2.78 ± 1.71 to 2.51 ± 1.78 μm (*p* = 0.001), and slight thickening of corneal epithelium were registered, whereas most of the corneal biomechanical measurements did not show statistically significant change. Two eyes demonstrated slight topographic regression.

PTK-CXL seems to be effective in arresting the progression of keratoconus, improving CDVA, flattening the cornea, regularizing the corneal surface, and reducing corneal HOAs.

## Knowledge translation of vision rehabilitation in a multidisciplinary stroke unit

Irene Langeeggen,<sup>1</sup> Grethe Eilertsen,<sup>2</sup> Heidi K. Ormstad,<sup>2</sup> Torgeir Mathisen,<sup>3</sup> Ann Iren H. Midskogen,<sup>4</sup> Helle K. Falkenberg<sup>1\*</sup>

<sup>1</sup> National Centre for Optics, Vision and Eye Care, Department of Optometry and Visual Science, Faculty of Health Science, University College of Southeast Norway, Kongsberg, 3616, Norway

<sup>2</sup> Institute of Nursing Science, Faculty of Health Sciences, Buskerud and Vestfold University College, Drammen, Norway

<sup>3</sup> Department of Neurology Kongsberg, Vestre Viken Hospital Trust, Kongsberg, Norway

<sup>4</sup> Department of Neurology Drammen, Vestre Viken Hospital Trust, Drammen, Norway

\* Corresponding author: [helle.k.falkenberg@hbv.no](mailto:helle.k.falkenberg@hbv.no)

### Abstract

Stroke is the third most common cause of death in industrialized countries and the most frequent cause of permanent adult disability and need for long-term rehabilitation and care. In Norway, 55 000 individuals are living with stroke and its consequences, and each year 15–16 000 new stroke events occur, of which 4–5 000 occur in individuals who have had a prior stroke. The World Health Organization (WHO) defines stroke as acute neurological deficits of cerebrovascular origin that persist beyond 24 hours or cause death within 24 hours. Visual impairments after cerebral stroke are common, affecting more than 60% of all survivors. Even so, impaired vision is one of the most commonly overlooked and under-treated conditions following a stroke. Problems include reduced visual acuity, visual field defects, eye movement disorders and perceptual deficits, and range from insignificant vision loss to total blindness. Vision loss is a risk factor for falls, reduced quality of life, activities of daily living, and additional distress. Early vision rehabilitation has positive implications for the outcome after stroke.

The aim of this intervention was to improve outcomes in stroke survivors by developing and implementing a clinical vision assessment tool for use in multidisciplinary stroke units. The intervention and vision assessment tool were developed using the two Knowledge-to-action (KTA) frame-

work components; knowledge creation and the action cycle. Based on the KTA multiple phases, the tailored intervention included a training program (2.5 days) and the implementation of a vision-screening tool. 43 hospital staff from two stroke units participated and included optometrists, ophthalmologists, nurses and occupational therapists. Evaluation included group interviews with 9 staff, and an eye exam of 30 patients at the University Eye Clinic. Interviews revealed that the vision assessment tool is used routinely, and the competence in detection of visual loss after stroke has increased. Preliminary results from 17 patients show that 7 were aware of vision changes, 8 had visual field loss, 8 had reduced VA, 3 experienced diplopia and 1 had neglect. The vision assessment tool identified these problems.

The KTA framework is useful in the development of clinical tools and complex interventions. Identifying barriers and tailoring the vision assessment tool to the stroke unit settings were key issues for implementing and sustaining the intervention. This study shows that improved competency in vision problems after stroke is important. The intervention shows improved outcomes for stroke survivors.

### Acknowledgements

Kongsberg and Drammen stroke units Vestre Viken Hospital Trust, Norsk forening for slagrammede, Norges Blindeforbund

## Exposure to Direct Glare during Computer Work and increased Muscle Blood Flow in the Neck

Randi Mork,<sup>1\*</sup> Knut Inge Fostervold,<sup>2</sup> Helle K. Falkenberg,<sup>1</sup> Hanne-Mari Schiøtz Thorud<sup>1</sup>

<sup>1</sup> National Centre for Optics, Vision and Eye Care, Department of Optometry and Visual Science, Faculty of Health Science, University College of Southeast Norway, Kongsberg, 3616, Norway

<sup>2</sup> Department of Psychology, Faculty of Social Sciences, University of Oslo, Oslo, Norway

\* Corresponding author: [randi.mork@hbv.no](mailto:randi.mork@hbv.no)

### Abstract

Poor visual ergonomics during computer work are associated with both eyestrain and affection of stabilizing muscles in the neck and shoulder area (Helland et al., 2008). Exposure to glare during computer work can also result in visual discomfort and development of eye symptoms (Thorud et al., 2012; Mork, Fostervold, & Thorud, 2015). Further, we recently showed a relationship between exposure to direct glare and increased muscle blood flow in trapezius (Mork et al., 2015). Previous research points toward a link between pain and increased blood flow, especially in subjects with chronic pain (Strom, Røe, & Knardahl, 2009). Increased blood flow and activity in trapezius (Lundberg et al., 2002; Larsson, Larsson, Zhang, Cai, & Oberg, 1995) and in facial muscles may also be caused by psychological stress (Vassend & Knardahl, 2005; Hidaka, Yanagi, & Takada, 2004).

The aim of the study was to investigate how exposure to visual stress (direct glare) and psychological stress affects m. orbicularis oculi and m. trapezius during computer work. In this study, 44 healthy, young women (21 ± 2 years, mean ± SD) with normal binocular vision participated with informed consent. All subjects went through a visual examination prior to testing. Four computer work sessions with different stress exposures were performed in a counterbalanced design: 1) Low stress, LS; 2) Visual stress

(direct glare), VS; 3) Psychological stress, PS; and 4) Visual and psychological stress, VPS. The psychological stress in PS and VPS was induced as time and efficiency pressure. Subjects were filmed during all conditions, and they were asked questions from the text after the computer work sessions. Sessions lasted for 10 minutes each with approximately 15 minute breaks in-between. The assignment in all four conditions was proofreading. Muscle activity (electromyography) and muscle blood flow (photoplethysmography) in the dominant m. trapezius and muscle blood flow in m. orbicularis oculi (dominant eye) were recorded continuously during computer work and during rest. Sitting posture was registered using inclinometers at the head and upper back.

The present abstract describes data collected in 2016 ( $n = 20$ ) and 2015 ( $n = 24$ ). The data from 2015 has been described previously (Mork, Bruenech, & Thorud, 2016).

Results show that there was significantly higher muscle blood flow in m. trapezius during the glare exposure conditions (VS and VPS) compared with the low stress condition. There was no significant difference between PS and any of the other conditions regarding trapezius blood flow. There were no significant differences in orbicularis oculi blood flow or trapezius muscle activity between the four conditions, but there were temporal effects in all conditions. Depending on the sitting posture, the subjects leaned significantly more forward in the two conditions with psychological stress (PS and VPS) compared to LS and VS during the computer work session. There was also an overall significant difference in head flexion between the conditions; the subjects had a more forward bent head during the computer work session in VPS compared to all the three other conditions. These differences in posture cannot explain the difference we see in trapezius blood flow during glare exposure.

### References

- Helland, M., Horgen, G., Kvikstad, T. M., Garthus, T., Bruenech, J. R., & Aaras, A. (2008). Musculoskeletal, visual and psychosocial stress in VDU operators after moving to an ergonomically designed office landscape. *Applied Ergonomics*, 39(3), 284–295. doi:10.1080/10803548.2008.11076765
- Hidaka, O., Yanagi, M., & Takada, K. (2004). Mental stress-induced physiological changes in the human masseter muscle. *J Dent Res*, 83, 227–231.
- Larsson, S. E., Larsson, R., Zhang, Q., Cai, H., & Oberg, P. A. (1995). Effects of psychophysiological stress on trapezius muscles blood flow and electromyography during static load. *Eur J Appl Physiol Occup Physiol*, 71(6), 493–498.
- Lundberg, U., Forsman, M., Zachau, G., Eklöf, M., Palmerud, G., Melin, B., & Kadefors, R. (2002). Effects of experimentally induced mental and physical stress on motor unit recruitment in the trapezius muscle. *Work & Stress*, 16(2), 166–178. doi:10.1080/02678370210136699
- Mork, R., Bruenech, J. R., & Thorud, H. M. S. (2016). Effect of Direct Glare on Orbicularis Oculi and Trapezius During Computer Reading. *Optometry & Vision Science*, 93(7), 738–749. doi:10.1097/OPX.0000000000000855
- Mork, R., Fostervold, K. I., & Thorud, H. M. S. (2015). Visual and Psychological Stress during Computer Work. *SJOVS*, 8(2), 2–2. doi:3
- Strom, V., Røe, C., & Knardahl, S. (2009). Work-induced pain, trapezius blood flux, and muscle activity in workers with chronic shoulder and neck pain. *PAIN*, 144(1-2), 147–155. doi:10.1016/j.pain.2009.04.002
- Thorud, H. M. S., Helland, M., Aaras, A., Kvikstad, T. M., Lindberg, L. G., & Horgen, G. (2012). Eye-related pain induced by visually demanding computer work. *Optom Vis Sci*, 89, 452–464. doi:10.1097/OPX.0b013e31824c1801
- Vassend, O., & Knardahl, S. (2005). Personality, affective response, and facial blood flow during brief cognitive tasks. *Int J Psychophysiol*, 55, 265–278. doi:10.1016/j.ijpsycho.2004.08.005

### Acknowledgements

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

## Personalized eye models based on clinical measurements

Nadeem M. Akram,<sup>1\*</sup> Jon V. B. Gjelle,<sup>2</sup> Rigmor C. Baraas<sup>2</sup>

<sup>1</sup> IMST, Institute of Microsystems, University College Southeast Norway, Boks 4, Borre, 3199, Norway

<sup>2</sup> National Centre for Optics, Vision and Eye Care, Department of Optometry and Visual Science, Faculty of Health Science, University College of Southeast Norway, Kongsberg, Norway

\* Corresponding author: [mna@hbv.no](mailto:mna@hbv.no)

### Abstract

The purpose of this study was to develop individual eye models based on clinical measurements of individual persons' eyes.

Ocular biometry included measurements of axial length, anterior chamber depth, corneal thickness, lens thickness, and front corneal radius (Zeiss IOLMaster 700). Objective refraction was measured under cycloplegia (Cyclopentolate 1%) with a wavefront-based autorefractor (Huvitz HRK-8000A Auto-REF Keratometer). Individual eye models were constructed in optical design software (OpticStudio 15, Zemax LLC) employing the measured parameters from biometry. Non-measured parameters, including dispersion of the eye and refractive index gradient of the lens, were based on Navarro eye model. The clinically measured spherical, cylindrical and axis (S/C-Ax) prescription of the eye was used as the primary criterion for fitting the eye's wavefront.

The measured wavefront Zernike coefficients of the eye are useful for developing individual eye models. The results of this study show how different eye models can be developed for a given S/C-Ax prescription.

## Outdoor activity time and refractive error among Norwegian adolescents

Lene A. Hagen, Jon V. B. Gjelle, Stuart J. Gilson, Rigmor C. Baraas\*

National Centre for Optics, Vision and Eye Care, Department of Optometry and Visual Science, Faculty of Health Science, University College of Southeast Norway, Kongsberg, 3616, Norway

\* Corresponding author: [rigmor.baraas@hbv.no](mailto:rigmor.baraas@hbv.no)

### Abstract

The prevalence of myopia is increasing in several parts of the world, and the onset of myopia is reported to occur at a younger age (McCullough, O'Donoghue, & Saunders, 2016). Studies have shown that time spent outdoors prevents the onset of myopia (Rose et al., 2008). The purpose of this study was to determine the prevalence of refractive errors among Norwegian adolescents and examine the association between refractive error and self-reported time spent on indoor- and outdoor-activities. A cross-sectional study was carried out in two upper secondary schools located in Buskerud County, Southeast Norway. Students (aged 16–25 years) participated in vision screening and answered a digital questionnaire. Objective refractions were obtained with Huvitz HRK-8000A Auto-REF Keratometer under cycloplegia.

This is the first study of refractive errors for this age group in Norway. The prevalence of myopia ( $SER \leq -0.50$  D) was 15% and for hyperopia ( $SER \geq +1.00$  D) it was 19%. Thus, the prevalence of myopia appears to be more or less unchanged over the last 45 years when compared with data from 12–14 year olds (Larsen, 1971). The prevalence of myopia is lower and hyperopia is higher in Norwegian adolescents than what is reported for the same age group in Asia (Dirani et al., 2009).

However, self-reported time spent outdoors was the same as that reported for Singapore adolescents, where the prevalence of myopia is as high as 70% (Dirani et al., 2009). Further research is needed to understand which factors delay the onset of myopia in Norwegians and thereby prevent many from developing high-grade myopia.

### References

Dirani, M., Tong, L., Gazzard, G., Zhang, X., Chia, A., Young, T. L., ... Saw, S. M. (2009). Outdoor activity and myopia in Singapore teenage children. *The British Journal of Ophthalmology*, 93(8), 997–1000. doi:10.1136/bjo.2008.150979

Larsen, J. S. (1971). The sagittal growth of the eye. 1. Ultrasonic measurement of the depth of the anterior chamber from birth to puberty. *Acta ophthalmologica*, 49(2), 239–262.

McCullough, S. J., O'Donoghue, L., & Saunders, K. J. (2016). Six year refractive change among white children and young adults: evidence for significant increase in myopia among white UK children. *PloS one*, 11(1). doi:10.1371/journal.pone.0146332

Rose, K. A., Morgan, I. G., Ip, J., Kifley, A., Huynh, S., Smith, W., & Mitchell, P. (2008). Outdoor activity reduces the prevalence of myopia in children. *Ophthalmology*, 115(8), 1279–1285. doi:10.1016/j.ophtha.2007.12.019

## Non-cycloplegic refraction in Norwegian children: comparison of retinoscopy with Huvitz HRK8000A and Shin-Nippon NVision-K 5001 autorefractors

Cecilie O. Bjørset,<sup>\*</sup> Jon V. B. Gjelle, Lene A. Hagen, Hilde R. Pedersen, Gro H. Vikesdal, Randi Mork, Trine Langaas, Rigmor C. Baraas, Ellen Svarverud

National Centre for Optics, Vision and Eye Care, Department of Optometry and Visual Science, Faculty of Health Science, University College of Southeast Norway, Kongsberg, 3616, Norway

\* Corresponding author: [cecilie.onshuus.bjorset@hbv.no](mailto:cecilie.onshuus.bjorset@hbv.no)

### Abstract

The purpose of this study was to estimate the prevalence of refractive errors and compare results from non-cycloplegic retinoscopy with a monocular Hartmann-Shack based [HRK8000A (HRK)] autorefractor and a wide field binocular [Shin-Nippon NVision-K 5001 (NVK)] autorefractor. Ninety-six children (49% male) in 5th grade ( $n = 43$ , 9–10 years) and 10th grade ( $n = 53$ , 15–16 years) participated in the study. Refraction was measured by retinoscopy and the two autorefractors (HRK and NVK) in a masked random order. An experienced optometrist performed retinoscopy, and trained students took the autorefractor measurements. NVK measurements were taken at both 6 m and 0.4 m. Sphere and cylinder values, spherical equivalent (SER), and power vectors (J0 and J45) were analysed. Accommodative responses were compared with refractive status. The results show that 12%, 67%, 22%, and 4% of the children had myopia ( $SER \leq -0.5$  DS), emmetropia ( $-0.50 < SER < +1.00$  DS), hyperopia ( $SER > 1.0$  DS), and astigmatism ( $\leq -0.75$  DC), respectively. There was no difference in measured sphere between retinoscopy and NVK ( $p = 0.773$ ), but both gave a significantly more positive sphere than HRK ( $p < 0.02$ ). Cylinder value was significantly more negative measured with NVK and HRK than with retinoscopy ( $p < 0.001$ ). Retinoscopy gave a significantly more positive SER than HRK ( $p < 0.001$ ). Bland-Altman plots showed good agreement between HRK and NVK for SER, J0 and J45. There was no difference in accommodative lag between the refractive groups ( $p = 0.335$ ). Myopia is less frequent whereas hyperopia is more frequent in Norwegian school children than what is reported for Asian

school children. Results from HRK and NVK showed good agreement, but non-cycloplegic retinoscopy performed by an experienced optometrist gave the most positive refraction, both for sphere and cylinder.

### The use of a questionnaire for symptoms in combination with visual function testing in vision screening of school children

Trine Langaas\*, Gro H. Vikesdal, Cecilie Bjørset, Jon V. B. Gjelle, Hilde R. Pedersen, Lene A. Hagen, Randi Mork, Stuart J. Gilson, Ellen Svarverud, Rigmor C. Baraas

National Centre for Optics, Vision and Eye Care, Department of Optometry and Visual Science, Faculty of Health Science, University College of Southeast Norway, Kongsberg, 3616, Norway

\* Corresponding author: [trine.langaas@hbv.no](mailto:trine.langaas@hbv.no)

#### Abstract

The aim of this study was to assess the relationship between measures of visual function and a short symptoms questionnaire. Visual function was measured in 96 children (43 in 5th grade (9–10 years) and 53 in 10th grade (15–16 years)), and all completed a symptoms questionnaire. Tests of visual function included habitual monocular distance visual acuity (VAd) and binocular near visual acuity (VAn), cover test (CT) at distance and near, near point of convergence (NPC), accommodation amplitude (AA), objective refraction and stereo vision (TNO). The questionnaire included 11 questions related to vision at distance and near, experience of blur, binocular vision, tiredness and headache. The questions had yes/no options, and a total symptom score (TSS) was calculated from the number of reported symptoms (yes = 1, no = 0). Mean TSS was  $1.9 \pm 2.2$  (range 0–9). Significant correlations were found between TSS and VAn ( $r = 0.27, p < 0.01$ ), AA ( $r = 0.34, p < 0.01$ ) and NPC ( $r = 0.21, p < 0.05$ ). Those reporting “blur on blackboard” (21.5%), “blur at near” (19.4%) or “tiredness when reading” (30.1%) had significantly poorer VAn (all  $p < 0.05$ ) and AA ( $p < 0.01; p < 0.001$  and  $p < 0.05$ , respectively) compared with those not reporting these symptoms. In addition, children reporting “blur at near” showed poorer NPC ( $p < 0.05$ ) and children reporting “blur at distance” showed poorer TNO ( $p < 0.05$ ). Interestingly, questions asking for “clear at distance/near” did not differentiate between normal and reduced values in visual functions. VAn and AA had the strongest association with reported symptoms. The wording of the questions was found to be of importance. The results showed that a well-worded short questionnaire suitable for children could identify those with poorer visual measures at near.

### Near vision status in a group of Norwegian school children aged 9–16

Ellen Svarverud\*, Gro H. Vikesdal, Cecilie O. Bjørset, Jon V. B. Gjelle, Hilde R. Pedersen, Lene A. Hagen, Randi Mork, Stuart J. Gilson, Rigmor C. Baraas, Trine Langaas

National Centre for Optics, Vision and Eye Care, Department of Optometry and Visual Science, Faculty of Health Science, University College of Southeast Norway, Kongsberg, 3603, Norway

\* Corresponding author: [ellens@hbv.no](mailto:ellens@hbv.no)

#### Abstract

Vision screening serves an important purpose of identifying

children with vision problems, but criteria for what should be considered normal are largely based on text-book values. Here, criteria for near vision measures were assessed in a group of Norwegian children. Ninety-six children in 5th grade ( $n = 43$ , 9–10 years old) and 10th grade ( $n = 53$ , 15–16 years old) participated in the study. The screening programme consisted of a symptoms questionnaire, monocular habitual visual acuity at distance (VAd), binocular habitual visual acuity at near (VAn), cover test (CT) distance and near, near point of convergence (NPC), accommodation amplitude (AA), and stereo vision. Non-cycloplegic retinoscopy was performed by an experienced optometrist. Children failing a set criteria were referred for a comprehensive eye examination. There were no differences in mean ( $\pm SD$ ) values between 5th and 10th graders in visual function, except for spherical equivalent refraction, SER ( $+0.55(\pm 0.97)$  DS and  $+0.09(\pm 0.93)$  DS,  $p = 0.02$ ). LogMAR VAd was  $0.01(\pm 0.11)$  and  $0.05(\pm 0.16)$ , and logMAR VAn was  $-0.01(\pm 0.16)$  and  $-0.04(\pm 0.10)$  for 5th and 10th graders respectively. CT was  $-0.5(\pm 2.0)$   $\Delta$ D and  $-1.5(\pm 3.0)$   $\Delta$ D at distance and near ( $n = 96$ ). NPC was  $6.5(\pm 4.0)$  cm ( $n = 96$ ) and AA values  $12.2(\pm 3.4)$  D (5th), and  $11.0(\pm 2.7)$  D (10th). A subgroup of non-referred emmetropes ( $-0.5$  D  $<$  SER  $<$  1.0 D) were defined as “normal” ( $n = 45$ ). Expected values for NPC and AA were calculated from their mean. Values just outside 95% CI were NPC 6.5 cm, AA 11.7 D (5th) and 10.3 D (10th). Using these values, 26.7% and 29% of our non-referred children may be regarded as having subnormal NPC and AA, while using text-book criteria for NPC ( $\geq 7.5$  cm) and AA (Hofstetter’s formula) these numbers would be 6.7% and 43%. Children’s near vision is more important than ever with increased use of near electronic devices. Estimated normal values of NPC and AA differed from text-book values, and further research is needed in revisiting these values.