Kongsberg Vision Meeting 2017: Abstracts

Kongsberg Vision Meeting was arranged at the University College of Southeast Norway in Kongsberg for the tenth time on October 24–26, 2017. The meeting was organised as a three-day meeting with a clinical day, research day and a lighting design day. Rigmor C. Baraas, Gro Horgen Vikesdal, Trine Langaas, Veronika Zaikina and Are Røysamb organised the three-day meeting. The theme this year was Vision, Light and Learning. Keynote speakers for the clinical optometry day and the research day were Rowan Candy and Anna Horwood. The keynote speakers for the light day were Imke W. Van Mil and Thorbjörn Laike. The abstracts from invited and contributed talks on the research day and the light day are presented first followed by posters, in the order they were given.

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The relationship between accommodation and vergence in the context of binocular function, from birth to school-age

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Abstract

Young infants must coordinate their retinal image quality and alignment in order to support normal binocular development (Candy, Wang, & Ravikumar, 2009; Babinsky & Candy, 2013). This presentation will cover the early development of the motor components of binocular function, including the challenges involved in overcoming immaturities in interocular distance and refractive error (Wang & Candy, 2010; Seemiller, Wang, & Candy, 2016; Bharadwaj & Candy, 2009; Sreenivasan, Babinsky, Wu, & Candy, 2016; Wu, Sreenivasan, Babinsky, & Candy, 2016). Implications for both typical and atypical development will be discussed (Candy, Gray, Hohenbary, & Lyon, 2012; Manh, Chen, Tarczy-Hornoch, Cotter, & Candy, 2015; Bharadwaj & Candy, 2011).

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Eye movements and dyslexia: Saccade latency, fixation stability and the relationship with optometric measures

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Abstract

The relationship between eye movement control and dyslexia is not well established, and subject to controversial claims. A number of studies have measured saccadic latency in dyslexia, but have not yielded consistent findings: both longer, similar and shorter saccadic latencies have been reported in children with dyslexia. Previous studies have suggested that children with dyslexia have unstable binocular fixation, and that the observed instability reflects decreased cognitive control rather than oculomotor dysfunction per se.

The significance of visual input to saccade latency and fixation stability is not well established. There are some reports of a higher incidence of optometric abnormalities in children with dyslexia, i.e. visual acuity and poor accommodation, while refractive errors do not appear to be more prevalent in children with dyslexia. Studies find that subjects with amblyopia have increased saccade latency and less stable fixation with the amblyopic eye compared to the fellow eye. However, induced blur does not seem to affect saccade latency and the effects of induced blur on fixation stability have conflicting results: both decreased and increased fixation stability have been reported. This study aimed to investigate the effects of optically induced refractive errors on saccade latency and fixation stability, and to evaluate the prevalence of optometric deficits in a population with dyslexia.

Sixteen healthy, young adults (two males), with normal visual acuity and normal accommodation, performed an eye movement experiment, consisting of a saccade task and a fixation task, wearing a range of contact lenses (from +3.00 to -5.00 dioptres) which induced visual blur and accommodation. Thirty-four children with and without dyslexia had an extensive optometric examination, before performing the same experiment.

Saccade latency remained stable with both visual blur and accommodation, whereas fixation stability declined with both visual blur and accommodation (Vikesdal & Langaas, 2016a). Children with dyslexia were more at-risk for conventional optometric deficits, and the most prevalent deficits were hypermetropia and accommodation insufficiency. Children with dyslexia exhibited less stable fixation compared to the control group, however, showed no deficit in control of saccades. Optometric deficits were not a significant contributing factor to fixation stability.

This study showed that saccade latency and fixation stability are reliable parameters for eye-movement experiments (Vikesdal & Langaas, 2016b). Visual function is compromised

for a portion of children with dyslexia, and a thorough optometric examination is indicated, including cycloplegic refraction. Saccade control appears to be normal in children with dyslexia, and is not under the influence of visual sensory input. Fixation is more unstable in children with dyslexia, and is more vulnerable to visual input. The findings support the theory of a different control mechanism for saccades and fixation.

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AC/A – CA/C – or neither? Why we should re-think some theoretical models

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Abstract

Clinicians are taught that the AC/A ratio is an important theoretical concept which should influence patient care. Theoretical teaching on the management of binocular vision problems is often based on this "fixed and stable" relationship – but in practice it is rarely used to change clinical decision-making. It is rarely measured well, and the ratio which is measured clinically is imprecise. While the AC/A relationship may be important for a small, select group of patients, the research in our laboratory suggests that, in general, the CA/C relationship is much more important in everyday conditions and many clinical situations. It is important to outline how issues relating to these relationships can impact on patient care and our understanding of binocular vision. We will go on to discuss how both the AC/A and CA/C linkages may be more flexible than generally considered.

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Modelling cue weighting for naturalistic vergence and accommodation responses

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Abstract

Averaging on the basis of cue weighting has been used to model, for example, perceptual estimates of target depth (Landy, Maloney, Johnston, & Young, 1995). In this study, we set out to determine whether a similar procedure would be effective when estimating physiological responses to targets in depth. Over the past 15 years, we have measured adult vergence responses to targets at different depths when different cues are available (Horwood & Riddell, 2008). We used this database to test whether the weighting of responses to single cue conditions (blur, disparity or proximal cues only) could predict the response when multiple cues are available. In order to test this, we modelled data from our substantial database of adult accommodation responses to targets at different depths when different cue combinations were present. We were not able to determine perceptual psychometric functions for individual cue sensitivity. Instead, sensitivity to individual cues was determined relative to a single prior derived from the intercept of the stimulus response function. The weights generated for the four single-cue conditions (blur only, disparity only, proximity only and a minimal cue conditions when all of these cues were minimised) were then used to predict responses to two- (blur and disparity, blur and proximity, disparity and proximity) and three-cue (blur disparity and proximity) conditions. Results demonstrated that a standard cue weighted average model provided a good fit to the gain of the vergence responses in the two and three cue conditions. Thus, differences in the weighted response to individual cues are sufficient to determine their relative contribution to driving the overall physiological response. We compared two possible models: one in which an average weight of all cues is used to determine the response and a second in which the response is based on the cue with the highest weighting ("winner take all"). Conditions in which disparity was available as a cue did not discriminate between these two models since disparity was always the most accurate, and therefore heavily weighted, cue. However, data from cue conditions in which disparity was not available favoured the cue weighted average model over a "winner take all" model.

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Visual function in premature vs. typical children

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Abstract

Despite seemingly good visual function, such as visual acuities at distance, many premature children struggle at school (Grunau, Whitfield, & Davis, 2002; Litt, Taylor, Klein, & Hack, 2005). This study evaluates different forms of visual function shown to be more related to learning ability. An observational cross-sectional case-/control-study of premature and typical children aged 5 to 10 years was used to evaluate a series of visual functions, reading- and cognitive skills. The index group consisted of premature children ($n = 37$), of whom a majority ($n = 25$) came from an established cohort of extremely premature children from the National Hospital in Oslo. This group was compared to typical Norwegian children ($n = 87$) from the same socio-economic environment. Children who were not attending or going to attend normal public education in Norway were excluded from the study.

Developmental trajectories were provided and compared for both groups in all functions. Ultimately, a factor analysis was performed to reduce the number of measures showing to latent variables with significant differences ($p < 0.05$; by ANCOVAs) between groups. Only minor or non-significant differences between premature and control children were found for the most common (typical) measures of vision. However, the results indicate that visual functions more related to academic performance were generally weaker in the premature group. These functions were found to generate two patterns of deficits: A Planar component that can be related to close work on screen or paper, and a Depth component that relates to accommodation and binocular functions. The two patterns were found to account for 66.6% of the total variance in our data. Premature children were found to have specific patterns of deficits in higher-level visual functions. Although reduced cognitive function in the most premature children is common, these results cannot be explained by reduced cognitive ability in our index group. It is therefore possible that more comprehensive visual examinations of these functions, and interventions designed to treat these deficiencies, could lead to improved learning abilities in premature children.

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How to illuminate learning environments well? A lighting designers' perspective

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Abstract

As designers of educational environments, it is a must to understand the physical as well as non-physical influence of our creations on its users. Elaborating on our approach to optimize the immaterial features of architecture is the focus of this presentation.

One of the key elements in achieving a good indoor climate in learning environments is daylight. When utilized wisely, daylight can improve students' wellbeing and indoor experience as well as reducing the building's level of energy consumption. Research evidenced that the right amount of daylight helps students to learn faster and achieve better results (World Green Building Council, 2013). Daylight is also a rich resource when it comes to designing a dynamic learning environment with great variation in intensity of light, color rendering, orientation and movement of light through the space (Henning Larsen Architects, 2012). These variations influence our experience of space, time and colors and herewith our motivation and ability to learn and be creative. The correct use of daylight, both quantitatively and qualitatively, thus supports our students' intellectual development (Gifford, 2007; Heschong Mahone Group – California energy commission, 2003). But as the availability of natural light differs per geographical location, facade design and orientation, and time of day/season, often electrical lighting is required to complement the natural light brought indoors. Foremost, to ensure students are able to comfortably see, read and write – or in other words for their visual system to function well – during all hours of use. Research also evidenced that electrical light equally effects our circadian rhythm, emotional wellbeing (i.e. mood, motivation) and social behaviour (Boyce, 2003). These have all been found to ultimately influence students' academic performance. Based on this knowledge, (national) building standards have been developed over time to safeguard that appropriate lighting installations are designed for our educational spaces.

Now that electrical lighting and control technology has been rapidly developing, more advanced opportunities occur for it to play an active role in generating "optimum" indoor conditions. One of such is the introduction of dynamic electrical lighting, which allows the indoor environment to behave as if "natural" when daylight itself is limited or not available. Or to apply level and color combinations that were found to stimulate certain behaviors such as activation or relaxation (Sleegers et al., 2012; Wessolowski, Koenig, Schulte-Markwort, & Barkmann, 2014). Both applications lead to electrical lighting being used to create different atmospheric settings within the same space, which each may support certain curricular activities or room usages. Atmospheric scenography by electrical lighting is an area of research presently ongoing in our practice. Through field experiments in a "live" learning environment: Frederiksbjerg Skole in Aarhus, we are exploring how to choreograph appropriate atmospheres with electrical light to support certain learning activities and needs. One specific hypothesis we are testing is whether focused, eye-level height lighting stimulates calmness amongst students, and possibly improves their ability to concentrate. Our preliminary analysis of collected data seems to indicate indeed lower student noise levels when such setting is activated, as well as greater environmental satisfaction. Further investigations are ongoing to explore additional implications to student concentration and other behavioral effects.

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Visual comfort and lighting quality in modern classrooms in Norway

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Abstract

Indoor environmental conditions in the classroom are crucial for students' performance and health (Vilcekova et al., 2017). This is even more important for younger school children as their bodies are still growing and developing. Daylight offers huge benefits in an educational environment, from improved concentration of the pupils to better sleep and health (Heschong, Wright, & Okura, 2002; Mott, Robinson, Walden, Burnette, & Rutherford, 2012; Shishegar & Boubekri, 2016). Recent reviews show that school buildings of compact plans prevail among others in Norway, also as award-winning projects. This means that more frequently energy efficient buildings will be built, resulting in minimized façade length, reduced window areas and daylight deficit (Houck, 2013). Good visual environment is frequently associated with adequate illuminance levels and glare prevention. It is a proven fact that inadequate illumination in the classroom reduces concentration and performance, causes headaches, eye strain and irritation, and increases absenteeism (Singh & Arora, 2014). Moreover, illumination (duration, timing, intensity and the spectral power distribution (SPD) of the light) have influence on occupants' circadian rhythms and, consequently, health. Therefore, school buildings should be designed not only to provide energy savings and visual performance, but to ensure visual comfort and health, taking into account non-visual effects of lighting. More attention should be given to the interaction between daylight and artificial light in order to guarantee the users' wellbeing. Lots of attention has been paid to human-centric lighting in the past years that claimed to be beneficial for visual performance, learning, sleep, alertness, mood and other health aspects (Boyce, 2016). Kongsgårdmoen school in Kongsberg, Norway has been called the first school in the world with the human-centric lighting installed in all classrooms. But how should a thoughtful person evaluate a claimed benefit of this lighting on pupils? Peter Boyce wrote in his editorial: "…there are important effects of light exposure operating through the circadian timing system, but we suspect that many other parts of the brain are influenced by light; yet these are relatively unexplored…Many remote outcomes of interest, such as better health, faster learning …are determined by many factors, lighting being just one of them" (Boyce, 2016). It is particularly true, as the latest studies show, that correlated colour temperature is an insufficient parameter in predicting how a light source will impact on the human circadian system (Bellia, Pedace, & Barbato, 2013). Interior surfaces can diminish the circadian efficacy of illumination through spectral distortions, and the choice of surface materials and colours has indirect effect on users' wellbeing (Bellia et al., 2013; Inanici, Brennan, & Clark, 2015). Therefore, visual comfort and lighting quality should be provided through thorough architectural-, interior- and lighting design activities concurrently. Nowadays lighting designers work separately from architects/interior designers, performing simulations to ensure required illuminances. However, this approach guarantees only sufficient visibility. To adequately stimulate the circadian system, it is necessary to evaluate illuminances at eye level along with the light SPDs and interior surface characteristics (Bellia et al., 2013). Children need to be housed not only in energy-efficient, but in safe and healthy environments. Therefore, it is important that architects are aware of importance of daylight and proper artificial lighting, this can be achieved through education and joint coordinated work of architects and lighting designers at early design stages.

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Lighting in the school – The impact of light on learning

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Abstract

The education of our children is a very important task and we need to facilitate the educational environment as much as possible. One environmental factor is light. I will present a short overview on how light has been treated over the years since public education became available for larger groups in the Western society. In the beginning natural daylight was the most prominent light source. Today, electric lighting has become the most common light source. There has been a development from incandescent light bulbs to the light emitting diodes. Today, there is a trend that we should make better use of the daylight especially because of the quality of the daylight. My presentation will highlight the non-visual effects of light and I will give examples from our own research as well as recent contributions from other researchers in the field.

The importance of optimal vision and lighting during near-visual work

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Abstract

Near-visual tasks, such as computer work, place a high demand on both smooth and cross-striated muscles in and around the eyes (Glimne, Seimyr, Ygge, Nylén, & Brautaset, 2013; Glimne, Brautaset, & Seimyr, 2015). Poor visual ergonomics, such as inadequate lighting, uncorrected refractive errors, and accommodative and binocular disorders, put extra stress on the visual system and head-stabilizing musculature, and may aggravate symptoms from the eyes and the neck and shoulder area (Rosenfield, 2011). Further, glare exposure during computer work has previously been shown to induce increased trapezius blood flow (Rosenfield, 2011), decreased reading performance (Lie & Watten, 1994), and decreased binocular vision control/increased fixation disparity variation (Fincham, 1951).

To elucidate the effect of exposure to glare during computer work further, the physiological responses and subjective symptoms/experiences during exposure to direct glare and psychological stress were investigated. Here we focus on the responses to glare. Forty-three healthy, young females with normal binocular vision participated with informed consent. The participants performed four 10-minute computer-work conditions (counterbalanced design), each of which contained different stress requirements, as follows: low stress (LS), visual stress (VS, direct glare), psychological stress (PS), and visual and psychological stress (VPS). The computer task was proofreading conducted on an optimized workstation. During computer work, continuous measurements were obtained for trapezius and orbicularis muscle blood flow (photoplethysmography), trapezius muscle activity (electromyography), head and back angles (dual-axis inclinometers), and blink rate (in PS and VPS). Subjective symptoms (eye-, head-, and neck/shoulder symptoms), psychological stress indicators (positive/negative state moods; stressed, comfortableness, concentrated, bored etc.), and perceived lighting were recorded using Visual Analogue Scales. Fixation disparity (FD) was measured using the Sheedy Fixation Disparometer. Exposure to direct glare during computer work resulted in increased muscle blood flow in trapezius, increased blink rate, a more forward-bent head, and increased eye tiredness, head tiredness, photophobia, and discomfort.

There were no correlations between posture and trapezius blood flow. Yet, there were indications of a connection between increased muscle blood flow in trapezius during glare exposure (VS and VPS) and neck and shoulder pain in all conditions. In the conditions with visual and/or psychological stress, back posture (leaning forward/backward) was correlated with change in FD relative to baseline. When comparing participants with little ($< \pm 2$ arcmin) and greater ($\geq \pm 4$ arcmin) FD-change, the ones with greater FD-change felt more stressed, perceived the lighting more unpleasant, and experienced more photophobia during glare exposure. Results indicate that direct glare exposure during computer work affects trapezius blood flow, posture, blink rate, and development of eye symptoms. During glare exposure, the results also indicate connections between binocular vision and the participants' experience of the environment and task. Further, it appears that young females with normal vision adjust posture according to their binocular visual system, or vice versa, when being exposed to additional stress during computer work. In summary, this study shows that optimizing computer work in order to ensure the workers' health and well-being requires a multidisciplinary approach, and optimizing workers' vision and visual environment must be included.

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What we know and what we think about light in learning environments

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Abstract

In Norway, as in most other countries, huge investments are made each year on new school buildings and rehabilitation of old schools. According to the Primary and Lower Secondary Education Act all pupils in Norway have the right to a good physical and psychosocial environment that promotes health, well-being and learning. The effect of daylight and artificial lighting on the human body has been discussed within the field of ergonomics and human factors for several decades. It is well known that light not only influences vision, but also determines circadian rhythms, affects psychophysiological activity levels, and mood. However, this knowledge seems to a rather limited extent to encompass learning environments and the design of schools. Initiated by The Norwegian Lighting Institute a project was launched in 2014. The aim was to develop updated guidelines for lighting in learning environments that should help school authorities and entrepreneurs to implement lighting systems that improve the learning environment and satisfy the needs of pupils and teachers. A first impression of the literature is that the design of learning environments often seems more influenced by architects, school authorities, interior designers and educational trends than scientific knowledge about lighting and its effect on learning and learning processes. To expand the knowledge base searches were conducted in scientific databases both for

direct and indirect effects of lighting on learning. Vischer's (2008) dimensions of a functionally comfortable workspace design were used as a guiding framework when interpreting the literature. The result is presented in the publication "light in learning environments". Although the literature makes it possible to point to some important features, the work also revealed an urgent need for more research on the connection between good efficient lighting and learning outcomes.

Measuring perceptual scales of perceived surface lightness: a comparison between MLDS and matching

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Abstract

Perceived lightness is often measured using a matching procedure where observers select or adjust a test field to match their percept of a target. Typically, one is interested in to what extent observers are lightness constant, i.e. to what extent they choose the same matches despite variations in the viewing conditions, and hence the retinal luminance of the target. Such a matching procedure is called *asymmetric* matching, which alludes to the potential problem that perceived lightness must be compared between different viewing conditions. The procedure used in maximum-likelihood difference scaling (MLDS) experiments on the other hand allows the estimation of perceptual scales from judgments of stimulus differences along one stimulus dimension. That is, different perceptual lightness scales can be obtained for lightness judgments performed within each context, and the estimated scales should theoretically map to the same internal scale. Here we wanted to test whether indeed the scales determined by MLDS map to the same perceptual scale for the perceptual attribute of surface lightness. To address this question, we measured perceived lightness as a function of different viewing contexts in a matching and an MLDS procedure. Stimuli were rendered images of variegated checkerboards. Perceived target lightness was assessed for ten different reflectance values and five different viewing contexts (plain view and four transparencies). In the transparency conditions, two thirds of the checkerboard were covered by the transparent layer. In the MLDS procedure we used a triad comparison, i.e. observers indicated which of two pairs of checks, that were presented in the same viewing context, appeared more different in lightness. In the matching procedure, observers adjusted an external test field to match the lightness of the target check. We found that in the MLDS procedure similar perceptual scales were estimated for each viewing context indicating a mapping to the same internal dimension. We also found a high correspondence between the scales derived with each of the two procedures. We simulated MLDS scales that would result from either luminance- or reflectance-based judgments, and the observed scales were more consistent with reflectance-based judgments. Observers reported unanimously that the triad comparison was the more intuitive task. So, it might provide an interesting alternative to standard matching procedures.

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Urban Light Spaces – demystified

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Abstract

Urban transformations in areas such as Hovinbyen – Oslo, might follow a phase where separate urban functions like production, work, living and leisure blend together in a mix of activities. Thus, creating a greater need for a well working public realm. Public and semi-public spaces will be used around the clock – and light and lighting should play an apparent role in making future urban light spaces answer to this challenge. The municipal plan "Strategisk plan for Hovinbyen" outlines 12 main strategic points for the development of this vast area. None of the points refer to light and lighting. The vision of attractive urban areas with safe and user friendly urban spaces does not emphasise the role of artificial lighting nor lighting design – in creating sustainable future public realms – outside daylight hours. This presentation introduces Kaplan & Kaplan's Preference Model as a tool for planners, developers and designers – dealing with lighting design. By incorporating environmental psychological understanding and concepts found in their model – into the urban lighting design process – better analyses will be made, better night-scapes created, and a new way of understanding the potential of night architecture emerges.

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Prevalence of Meibomian Gland Dysfunction Among People Seeking Ophthalmological Care for Dry Eye Disease

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Abstract

The aim was to estimate the prevalence of meibomian gland dysfunction among Norwegian patients examined for dry eye disease in an ophthalmological practice. A total of 916 patients (mean age 53 ± 16 years, 74% were female) were examined at the Norwegian Dry Eye Clinic for the first time, either referred by other eye care professionals or self-referred.

All patients answered a questionnaire on dry eye symptoms, the Ocular Surface Disease Index (OSDI), and were submitted to extensive dry eye tests, including assessment of meibum quality and expressibility. Patients were categorized according to OSDI score (0–100) into four categories of dry eye symptoms; normal ($<$ 13), mild (13–22), moderate (23–32) and severe (33–100) (Tomlinson et al., 2011; Dougherty, Nichols, & Bichols, 2011; Schiffman, Christianson, Jacobsen, Hirsch, & Reis, 2000; Miller et al., 2010). Meibomian gland dysfunction (MGD) was diagnosed as being either present or non-present based on the score for meibum quality (0–3) and expressibility (0–3) with respect to age. A score of greater than 1 for quality or expressibility is considered abnormal in patients $\leq$ 20 years. For patients $>$ 20 a score of 1 for both, or of $>$ 1 for either, is considered abnormal (Bron, 2001). The overall prevalence of meibomian gland dysfunction in patients with either one or both eyes diagnosed with MGD was 96%. There was no statistically significant difference in the prevalence of MGD with regard to gender or age. The severity of dry eye symptoms was normal, mild, moderate or severe in 17%, 17%, 15% and 51% of the total study population, respectively. Meibomian gland dysfunction is highly prevalent amongst patients with dry eye disease symptoms seeking eye care.

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Tear Osmolarity Measurements in a Norwegian Cohort of Patients with Clinically Evident Dry Eye Disease

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Abstract

Tear osmolarity (TO) measurement in dry eye disease (DED) has been discussed extensively in recent years. Different cut-off values detecting DED have been proposed. The proposed cut-off values range from 300 mOsm/L to 320 mOsm/L and there is no consensus on a certain cut-off value for TO levels. It is generally accepted that the cut-off value of 308 mOsm/L serves as a differentiator of dry eye condition from normal eyes. Here we study the detecting ability of tear osmolarity measurement in clinically evident (DED). A total of 443 patients suffering from DED with different aetiology were included in this retrospective study. The study was carried out at the Norwegian Dry Eye Clinic in Oslo between 2015 and 2017. All participants underwent comprehensive dry eye examinations including subjective evaluation of ocular dryness with Ocular Surface Disease Index (OSDI) questionnaire, measurement of tear osmolarity (TearLab Osmolarity System) and tear fluorescein break-up time (TFBUT). Patients reporting subjective feeling of ocular dryness as measured using the Ocular Surface Disease Index (OSDI) questionnaire and obtaining score $>$ 12 were included. As an additional inclusion criterion, all patients had to have TFBUT $<$ 5 seconds. All patients had clinically evident DED classified according to the Dry Eye Workshop Report 2007 (DEWS 2007). A total of six different cut-off values (290, 295, 300, 308, 310 and 316 mOsm/L) were used and above the threshold percentage was analysed. Mean age of the study participants was 51 (range 9-91), whereof 65% female. Mean OSDI and TFBUT was 43.4 $\pm$ 19.4 and 2.5 $\pm$ 1.3, respectively. At the cut-off value 290 mOsm/L, 3% of the dry eye patients were classed as normal. As the cut-off values increased, the percentage of dry eye patients who were classed as normal (false-negative) also increased. The percentage of dry eye patients classed as normal was 5% at 295 mOsm/L, 11% at 300 mOsm/L, 32% at 308 mOsm/L, 36% at 310 mOsm/L and 57% at 316 mOsm/L cut-off values. The recommended cut-off values for tear osmolarity levels measured with TearLab Osmolarity System seem to exclude some of the clinically evident DED cases.

Interocular Difference in Tear Film Break-up Time in a Norwegian Cohort of Dry Eye Patients

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Abstract

The aim was to investigate the interocular difference in tear film break-up time (TFBUT) between the eyes in a large cohort of Norwegian dry eye patients. Three hundred and one patients were consecutively included in the study. The study was carried out at the Norwegian Dry Eye Disease Clinic in Oslo, Norway from January through June of 2016. All patients underwent a comprehensive dry eye examination, including TFBUT. TFBUT is the time interval from a blink until the first appearance of a dry spot in the tear film. Fluorescein sodium 2% 5 L was used in the test. The ocular surface was visualized using a yellow barrier-filter with the cobalt blue light of the slit lamp. A Wilcoxon signed rank test was performed on the TFBUT values of the right and left eye. Patients were then divided into four subgroups (absolute interocular difference of 0, 1-3, 4-6, and 7+). Mean age in the study was 54 $\pm$ 16 years, 79% female. TFBUT values from 301 patients for the right and left eye was 3.42 $\pm$ 3.35 and 3.45 $\pm$ 3.45 respectively (p = 0.904). Subgroup analysis showed that 51.5% of patients had no difference in TFBUT-scores between the

eyes, 40.2% had a difference of 1-3, 5.6% a difference of 4-6, and 2.7% a difference greater than 7. Dry eye disease is a bilateral condition. Special attention should be given, and a retest performed when a difference greater than 3 is observed.

Gender differences in symptoms and signs of dry eye disease in patients under 40 years old

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Abstract

The aim was to investigate the gender disparities in dry eye symptoms and signs in a Norwegian cohort of patients under 40 years old. Two hundred and forty-seven patients (106 male, age 29.6 ± 6.7 years; 141 female, age 30.5 ± 5.7 years) under 40 years old, diagnosed with DED of different aetiologies, were recruited. Dry eye severity level (DESL) was determined based on the 2007 international Dry Eye Workshop. Gender differences in Ocular Surface Disease Index (OSDI) questionnaire score, tear osmolarity, tear break-up time (TBUT), ocular surface and corneal staining, Schirmer I test, meibomian gland expressibility and meibum quality were analysed. General linear model was used to adjust factor of age in inter-group comparisons. Between female and male patients, no statistically significant differences in OSDI score (33.9 ± 22.8 vs. 32.1 ± 18.2, $p = 0.515$), osmolarity (312.2 ± 13.4 vs. 309.8 ± 13.3 mOsm/L, $p = 0.461$), TBUT (5.5 ± 4.3 vs. 6.6 ± 4.7 seconds, $p = 0.089$), ocular surface staining (1.7 ± 2.0 vs. 1.4 ± 1.8, $p = 0.403$) and corneal staining (0.6 ± 1.0 vs. 0.4 ± 0.8, $p = 0.162$), Schirmer I test (19.0 ± 11.4 vs. 18.22 ± 10.9 mm, = 0.489), meibomian gland expressibility (1.0 ± 0.9 vs. 0.8 ± 1.0, $p = 0.198$), meibum quality (7.9 ± 4.8 vs. 8.4 ± 5.5, $p = 0.416$), or DESL (2.0 ± 0.5 vs. 1.9 ± 0.4, $p = 0.115$) were found. No significant gender differences were found in dry eye symptoms or clinical signs in patients under 40 years old.

Investigation of ocular biometry in persons with congenital aniridia

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Abstract

Congenital aniridia is a condition typically caused by a *PAX6* gene mutation. The *PAX6* gene is involved in the regulation of the transcription of other genes which are crucial for normal eye development (Landsend et al., 2017). A dysfunction may affect several ocular structures and cause varying degree of visual impairment (Tzoulaki, White, & Hanson, 2005). Absence or hypoplasia of the iris, foveal hypoplasia and nystagmus are some of the common ocular features of aniridia, with a considerable phenotypic heterogeneity between and within families (Hingorani, Williamson, Moore, & van Heyningen, 2009). *PAX6* mutations has also previously been linked to high refractive errors, although the mechanism is poorly understood (Hewitt et al., 2007). The purpose of this study was to investigate refractive errors and ocular biometry in congenital aniridia. Thirty-five persons with aniridia (13 males), aged 9–72 years, and 40 normal controls (17 males), aged 10–74 years, were included in the study. Refractive error was measured, and best corrected distance visual acuity was assessed with a high-contrast logMAR acuity chart. Ocular biometry, including ocular axial length, corneal radius, central corneal thickness, anterior chamber depth, lens thickness and vitreous chamber depth were measured with the Zeiss IOLMaster 700. CR was also measured with the Oculus Pentacam HR. Aniridia was associated with a broad range of refractive errors (-20.25–12.75 spherical equivalent refraction) and 80% had astigmatism. Visual acuity ranged from normal (0.00 logMAR) to category 4 blindness (light perception) ("International Statistical Classification of Diseases and Related Health Problems", 2015). There was a larger variation in ocular biometry measurements in persons with aniridia compared with the normal controls. The anterior chambers were significantly shallower, and corneas were thicker than those of normal controls. In aniridia, axial length, vitreous chamber depth and refractive error was independent of age. High grade myopia was observed in individuals with excessively deep vitreous chamber, whereas vitreous chamber depth was excessively shallow in those with high grade hyperopia. Vitreous chamber depth was the greatest contributor to the magnitude of the refractive error. Refractive phenotype, with prevalent high refractive errors including both myopia, hyperopia and astigmatism that was independent of age, suggests a dysregulation of eye development, consistent with impaired emmetropization in aniridia. Both genetic influences and visual functional abnormalities may play a role in this process, which requires further investigation.

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Eye Cosmetic Products and a Known Eye Irritant

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Abstract

Preservatives are used in personal care and beauty products, including eye cosmetics. While preservatives help to prevent contamination from bacteria and other microorganisms for longer, some preservatives have been shown to be toxic and irritating to human eyes. One such preservative is phenoxyethanol, which is frequently used as a substitute for parabens as it has fewer adverse effects. Cosmetic products containing phenoxyethanol are marketed as "paraben-free". Here we investigated whether popular eye cosmetic products contain the known substance, phenoxyethanol, classified as an eye irritant under the Harmonised Classification and Labelling, approved by the European Union. The study was carried out at the Norwegian Dry Eye Clinic in the period between June and September 2017. Data were collected from a total of 114 eye cosmetic products, whereof 37 mascara-, 26 eyeliner- and 51 eye shadow products. The ingredient list of each product was studied carefully. The databases of European Chemical Agency of the European Union and Environmental Working Group Cosmetics were used to determine the toxicity of phenoxyethanol. 30 out of 37 (80%) mascara products were found to contain the substance phenoxyethanol. Similar results were found for eye shadow products, where 39 of 51 (76%) displayed the substance in their ingredient list. The eyeliner products category had the lowest percentage; 35% (9 of 26). A total 68% (78 of 114) of the studied products were found to contain phenoxyethanol. According to the European Chemical Agency, phenoxyethanol is classified as a harmful substance causing eye irritation. It is also known as a substance likely to cause allergic reactions or inflammation in the eyes. Patients with dry eye disease need special guidance with regard to their use of eye cosmetics to avoid possible harmful ingredients.

Preservative-Free Eye Drops for Dry Eye Disease! How about Eye Cosmetics?!

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Abstract

The aim was to investigate preservative content of mascara products that potentially may exacerbate dry eye signs and symptoms. Preservatives such as parabens in eye drops have been documented to be toxic and to exacerbate the feeling of ocular dryness (Ng, Evans, North, Jones, & Purslow, 2016). The study group obtained data on mascara products from physical and online stores in the Oslo area. Data from a total of 37 popular mascara products were collected. The ingredient list of each product was studied carefully. Environmental Working Group Cosmetics Database was used to determine toxicity of found substances. All of the products contained one or more preservatives with documented ocular surface toxicity. One of the most frequently used preservative was a family of parabens. Fourteen out of 37 products (37.8%) contained at least one of the following preservatives from the family of parabens: methylparaben, ethylparaben, propylparaben, butylparaben or isobutylparaben. Almost 22% of the products contained two or more parabens. More than 16% of the products contained three or more parabens. Parabens are known to have moderate to high hazard concerns on human health. Hazards include endocrine disruption, allergies and immunotoxicity. In products without parabens it was frequently seen that another common preservative – phenoxyethanol – was used. In dry eye disease management, patient education on eye cosmetic products has paramount importance. Patients must receive guidance to use not only preservative-free eye drops, but also cosmetic products without preservatives with documented toxicity.

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Accurate wide-field emmetropic human eye model based on ocular wavefront measurements

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Abstract

Increasing prevalence of myopia and of elderly people with central vision loss due to age-related changes calls for a better understanding of peripheral optics of the human eye and its correction. The aim here was to develop an anatomically correct wide-field human eye model that accurately predicts the wavefront of the emmetropic eye across the visual field. Using a lens design program, a human eye model was constructed based on ocular wavefront measurements of 30 healthy young emmetropic individuals over a wide visual field. The model is different from previously published models as it does not use a Gradient index lens, which simplifies optical modelling and ray tracing without compromising accuracy. In addition, the cornea and the lens components could be tilted, decentred and rotated to improve the fit to the measured wavefronts. The RMS wavefront error, wavefront shape, asymmetries and dispersion properties of the developed model closely matched the measured values. The generic wide-field model can also be used to develop personalized eye models, which is of importance in understanding eye development, and when designing lenses for myopia control and low vision optical aids.

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Tear production levels and dry eye disease severity in a large Norwegian cohort

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Abstract

The aim was to investigate clinical parameters in a large Norwegian cohort of dry eye disease (DED) patients grouped into six levels of tear production. One thousand and ninety subjects diagnosed with DED of different aetiologies were recruited (796 female and 294 male). All patients received an extensive dry eye work-up. The cohort was divided into six groups: below and above cut-off values of 5 mm (groups 1 and 2), 10 mm (groups 3 and 4) and 15 mm (groups 5 and 6) of Schirmer I test (ST). Mann-Whitney test and Chi-Square test were used for group comparison of parameters. Data are presented as mean and standard deviation. P values less than 0.05 were considered significant. Mean age in the study was 52.86 $\pm$ 16.03 years (range: 8-95). The analysis revealed that groups 1, 3, and 5 (below defined cut-off values) had values indicating more severe DED than groups 2, 4 and 6 (above defined cut-off values) with significant difference in dry eye severity level (DESL), osmolarity (Osm), tear film break-up time (TFBUT), ocular protection index (OPI), ocular surface staining (OSS) and tear meniscus height (TMH). Using cut-off of $\leq$ 5 mm, for example, the calculated values were: DESL (2.15 $\pm$ 0.073 vs. 2.00 $\pm$ 0.025, $p < 0.001$) Osm (320.08 $\pm$ 2.247 vs. 314.77 $\pm$ 0.848 mOsm/L, TFBUT (3.07 $\pm$ 0.338 vs. 3.8 8$\pm$ 0.159 sec, $p < 0.001$), OPI (1.243 $\pm$ 0.131 vs. 1.656 $\pm$ 0.082, $p < 0.001$) and OSS (2.10 $\pm$ 0.322 vs. 1.62 $\pm$ 0.099, $p<$ 0.001). Regardless of the choice of cut-off values, there was no statistically significant difference in meibum expressibility (ME), meibum quality (MQ) and meibomian gland dysfunction (MGD) between groups below and above selected cut off value. Patients with lower tear production levels presented with more severe DED, irrespective of whether the Schirmer I cut-off value was defined as 5, 10 or 15 mm. ST is a robust discriminator for DESL, Osm, TFBUT, OPI, OSS and TMH, but not for ME, MQ and MGD.

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Norwegian Dry Eye Clinic and Oslo University Hospital

Assessment of Dry Eye Related Quality of Life in a Norwegian Cohort of Dry Eye Patients

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Abstract

The aim was to assess dry eye related quality of life in patient groups with low ($<$ 12) and high ($\geq$ 13) Ocular Surface Disease Index (OSDI) scores. Seventeen patients (44 $\pm$ 15 years) with OSDI score $\leq$ 12 (low OSDI group) and 48 patients (48 $\pm$ 13 years, $p = 0.08$) with OSDI score $\geq$ 13 (high OSDI group) were included in the study. Subjective symptoms were evaluated with Ocular Surface Disease Index (OSDI) questionnaire. The OSDI score less than 12 defines the ocular surface as normal while the score higher than 13 indicates dry eye disease. Dry eye related quality of life was measured with Dry Eye-related Quality-of-Life Score (DEQS) questionnaire. DEQS range is 0-100, the highest indicating lowest dry eye related quality of life. All patients underwent complete dry eye disease work-up including tear osmolarity measurement (TO),

tear fluorescein break-up time (TFBUT), Schirmer test and ocular surface staining (OSS). Dry eye severity level (DESL) was assessed according to Dry Eye Workshop 2007. Mann-Whitney U test and Spearman rank correlation were used for analyses. P value 0.05 was considered significant. Results are presented as means and standard deviations. Patients with high OSDI scores demonstrated with high DEQS (73.4 $\pm$ 24.6) compared to patients with low OSDI scores (42.7 $\pm$ 21.6, $p < 0.01$). There were no statistically significant differences between objective dry eye tests in groups of low OSDI vs high OSDI scores: TO (309 $\pm$ 12 vs. 307 $\pm$ 18, $p = 0.78$), TFBUT (2.4 $\pm$ 1.1 vs. 2.6 $\pm$ 2.2, $p = 0.62$), Schirmer test (14.1 $\pm$ 10.8 vs. 14.4 $\pm$ 10.0, $p = 0.45$), OSS (2.4 $\pm$ 1.4 vs. 2.9 $\pm$ 2.2, $p = 0.38$) and DESL (2.5 $\pm$ 0.6 vs. 2.3 $\pm$ 0.6, $p = 0.25$). Correlation analyses revealed strong correlation between DEQS and OSDI ($r = 0.75$, $p < 0.01$). DEQS questionnaire can be used in a clinical setting to evaluate dry eye related quality of life. Self-reported quality of life measurements give better insight than objective tests in understanding impact of dry eye disease on quality of life.

Characteristics of Dry Eye Disease in Two Different Age Groups in a Norwegian Cohort of Dry Eye Patients

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Abstract

The aim of this study was to investigate characteristics of dry eye disease parameters in female patients aged under 30 years (Group 1) and over 60 years (Group 2) in a Norwegian cohort of dry eye patients. Towards this aim, 538 female patients diagnosed with dry eye disease were included in the study. Group 1 consisted of 95 patients (25.5 $\pm$ 4.5) while Group 2 included 443 patients (71.4 $\pm$ 41.5, $p < 0.01$). All participants underwent comprehensive ophthalmological examinations including Ocular Surface Disease Index (OSDI) questionnaire, measurements of tear osmolarity (TO), tear film break-up time (TFBUT), blink interval (BI), Schirmer test (ST), vital staining (VS), corneal sensitivity (CS), meibum quality (MQ) and meibum expressibility (ME). Dry eye severity level (DESL) was evaluated based on Dry Eye Workshop 2007 (DEWS 2007). Mann-Whitney U test was employed as a statistical tool. Results are given in means and standard deviations. Our results show that, Group 1 had higher TFBUT (4.6 $\pm$ 3.8 vs. 3.4 $\pm$ 3.1, $p < 0.01$), ST readings (18.1 $\pm$ 11.2 vs. 13.0 $\pm$ 9.2, $p < 0.01$) and DESL (2.0 $\pm$ 0.5 vs. 2.2 $\pm$ 0.6, $p = 0.01$). Interestingly, Group 1 showed higher MQ scores (9.5 $\pm$ 4.7) and lower ME scores (1.5 $\pm$ 0.9) than Group 2, 7.9 $\pm$ 5.1 ($p < 0.01$) and 1.7 $\pm$ 0.9 ($p = 0.02$), respectively. Comparison between scores for OSDI (Group 1: 36.5 $\pm$ 24.5 vs. Group 2: 36.1 $\pm$ 21.8, $p = 0.90$), TO (Group 1: 312.4 $\pm$ 20.2 vs. Group 2: 314.6 $\pm$ 18.5, $p = 0.34$), and VS (Group 1: 1.7 $\pm$ 1.8 vs. Group 2: 2.0 $\pm$ 2.3, $p = 0.39$) did not show statistically significant results. In conclusion, subjective evaluation with OSDI and objective evaluation with tear osmolarity and vital staining do not differentiate dry eye disease characteristics between young and elderly patients.

Comparison of 16-year-old female and male schematic eye models

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Abstract

The purpose of this study was to develop refraction-dependent and emmetropic eye models based on biometric data from Norwegian 16-year-old upper-secondary school pupils. Ocular biometry (axial length, anterior chamber depth, central corneal thickness, lens thickness, corneal radius of curvature; Zeiss IOLMaster) and cycloplegic refraction (Huvitz HRK-8000A) was collected from 225 (57.3% female) 16-year-old pupils in two local upper-secondary schools. Individual three-surface models based on the Gullstrand-Emsley schematic eye were constructed in OpticStudio (ZZEMAX LLC). The models were calculated using a spectacle correction equal to measured spherical equivalent refraction ($SER = sphere + 1/2cylinder$) at a 13.5 mm vertex distance. The refractive index of the lens was 1.416, and refractive indices of the cornea, aqueous chamber and vitreous chamber were 1.333. Front- (R1) and back-surface (R2) curvature of the crystalline lens were optimised in OpticStudio through a merit function which varied R1 and R2 to give best focus at the retina, while forcing the same ratio of crystalline lens surface powers ($R1/R2$) as in Gullstrand-Emsley schematic eye (Li et al., 2015). Aqueous chamber depth was calculated as anterior chamber depth minus central corneal thickness. All other parameters were taken from measured biometry. Seventy-one-participants (47.9% female) were emmetropic (-0.50 D < SER < +0.50 D). Emmetropic females had shallower aqueous chamber, shorter total axial length, steeper R1 and flatter R2 compared to emmetropic males. There was no significant difference in mean SER or corneal radius (CR) between female and male emmetropic eye models. When including all eye models, females had shallower aqueous chambers, thicker crystalline lenses, shallower vitreous chambers), shorter total axial lengths, steeper R1 and flatter R2 compared to males. Individual eye models based on the Gullstrand-Emsley schematic eye show that emmetropic females have shorter eyes and shallower aqueous chambers compared to emmetropic males, this difference is not compensated for by corneal radius, but rather by crystalline lens curvature.

References

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