The Future of Eye Care

The year 2023 witnessed a significant impact of machine learning (ML) and artificial intelligence (AI) algorithms on eyecare services. These technologies are becoming increasingly ubiquitous in high street clinical practices around Northern-Europe. As we move forward, there is no doubt that such algorithms will play major roles in first-line vision- and eyecare provided by optometrists and other professionals. While the potential of ML and AI will be immensely useful, it is imperative to recognise and address its limitations. This emphasis on understanding both the utility and constraints of ML and AI was a central theme at the 15th Kongsberg Vision Meeting, the abstracts of which are published in this issue (Baraas & Falkenberg, 2023).

The efficiency gains offered by ML and AI, such as those aiding refraction in a busy practice are apparent, but failing to see the limitations and addressing this in an appropriate manner may have consequences for individual patients. The inherent bias in any algorithm is something that requires understanding and thought. It raises the ethical bar for eyecare professionals and practice. In our commitment to advancing patient care, it is crucial to continually evolve bachelor- and master-degree programs to stay attuned to the dynamic landscape that will be shaped by ML and AI in the future. Additionally, eyecare providers in clinical practice should have access to research-based knowledge both in written and oral form that will foster interactive discussions.

To bridge the gap between research and practice, *SJOVS* introduced "The Optometry Hour" webinar in Norway. This one-hour online session features two 15-minute presentations by first-authors of two papers published in *SJOVS*, aimed at vision- and eyecare professionals in clinical practice. The presentations are followed by an open discussion related to the clinical significance of the presented papers and reflections on how this can aid development of evidence based clinical practice. The choice of Norwegian as the presentation language removes the language barriers and facilitates efficient knowledge translation of research to clinical practice. Having conducted two successful webinars in 2023, our intention is to continue this initiative in 2024, and to translate the concept to other countries and languages.

We encourage researchers, eye care professionals and related professionals to submit their work to be considered for publication in a *SJOVS* standard issue. If accepted, manuscripts will be included in the online collection of the given special topic. The latest special topic is announced in this issue of *SJOVS*, and this is: vision and stroke. The special topic editorial on vision and stroke screening is authored by guest editor Associate Professor Torgeir Solberg Mathisen and the *SJOVS* Associate Editors Helle K. Falkenberg and António Filipe Macedo (Mathisen et al., 2023).

Unfortunately, there are many individuals who have never had an eye exam and who are unaware that they may have a vision or eye health problem. This is a concern not only in developing countries, but also in Northern and Western Europe. Visual acuity charts are still by far the most ubiquitous tool for screening for vision and eye health problems. Jaffray et al. (2023) have compared the Arclight Cloth Chart (ARCchart) to the gold standard ETDRS chart for visual acuity. In this issue you can read more about the use of this, and how it may prove to become a valuable low-cost tool for testing visual acuity in resource-poor settings.

We are nearing the end of 2023, and we are all hoping for the world to be more peaceful in 2024. The *SJOVS* editorial board wishes everyone Happy Holidays and a Happy New Year.

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Stroke and vision, special topic call for papers

The ability to see and interpret the visual world is perhaps the most valued of the human senses and is likely to be impaired by brain disease. This means that any form of brain damage, such as stroke, traumatic brain injury, tumours or neurological diseases can affect the visual function. Stroke is the most common acquired cause of neurological impairment in the adult population. More than 60% of all stroke survivors experience a vision problem after stroke (Rowe et al., 2019). Stroke is the second most common cause of death and disability worldwide, including the Scandinavian countries. Worldwide, there are over 12 million stroke incidents per year and a prevalence of 101 million cases (Feigin et al., 2021).

This editorial provides the authors' view on the challenges of vision rehabilitation after stroke from a Norwegian perspective in a global context. In Norway and other Scandinavian countries there are still challenges in ensuring all stroke survivors get their vision assessed and individuals with vision impairment are referred to relevant vision rehabilitation.

In Norway and Denmark, approximately 12 000 persons per year, or 30 persons per day, will have a stroke, and in Sweden the number is twice that (Stevens et al., 2017). This means that in the Nordic countries, almost 30 000 stroke survivors will experience vision impairment after stroke. The total cost of stroke cases per year is estimated to be €677 million in Denmark, €926 million in Norway and €1.455 million in Sweden. In the western world the median age of people suffering stroke is 75 years and because the population is ageing, the number of strokes will increase by 27% until 2047 (Wafa et al., 2020). This will put an increased burden on the health care system and on the rehabilitation systems, in particular vision rehabilitation which is our focus in this special topic editorial.

Post stroke visual impairments include reduced visual acuity, visual field defects, eye movement disorders and a variety of visual perception disorders (Hepworth & Rowe, 2016). Visual impairments are associated with an increase in falls, difficulties with activities of daily living, fatigue, and poor rehabilitation outcomes (Pedersen et al., 2023; Terroni et al., 2012; White et al., 2015). Regardless of severity, much can be done through vision rehabilitation to aid recovery from post stroke visual impairments and improve visual functions (Howard & Rowe, 2018; Rowe, Hanna, et al., 2018). Several studies conclude that assessing visual functions will raise self-awareness, and compensatory training is useful for vision outcomes and the general rehabilitation process (Ackerman et al., 2014; Smedslund & Myrhaug, 2017).

In Norway, the national guidelines state that vision should be assessed after stroke, and patients with visual problems should be referred to an ophthalmologist, optometrist, or other eye-care specialist. The guidelines also state that compensatory training after visual field loss should be recommended (Norwegian Directorate of Health, 2017). Learning to live with a sudden loss of vision is a complex task closely intertwined with existential and social aspects (Nyman et al., 2010). Failing to identify visual problems after stroke can have a severe negative impact on the patient's coping, further recovery and quality of life (Falkenberg et al., 2020; Hepworth & Rowe, 2016; Hepworth et al., 2021; Tharaldsen et al., 2020). Early identification of post stroke visual impairments followed by individual information and education, together with vision rehabilitation at the right time may reduce these negative consequences (Mathisen et al., 2021; Mathisen et al., 2022; Rowe, Hepworth, Howard, Hanna, & Currie, 2020). Vision rehabilitation may contribute to improving quality of life and reducing the need for formal or informal care and is likely to improve general rehabilitation outcomes.

Visual problems remain one of the most overlooked and under-treated sequelae following stroke (Lofthus & Olsvik, 2012; Rowe, 2017; Sand et al., 2012). One reason is that health care professionals state that they fail to refer stroke patients for vision examination and vision rehabilitation because there is a lack of services (Huseby et al., 2017). Another reason is that visual functions are inadequately documented and there is a lack of systematic assessment, treatment or rehabilitation strategy (Mathisen et al., 2022). A third reason is that symptoms of visual problems are often missed by both patients and stroke care professionals (Mathisen et al., 2021). Symptoms of vision problems can also reveal impairments that that go beyond the visual system, and much can be gained about other sequelae of stroke by identifying the underlying cause. In short, there is a risk that patients are being discharged from hospitals into the community without anyone being aware of visual problems that may limit the success of other rehabilitation, the degree of recovery, and quality of everyday life (Berthold-Lindstedt et al., 2017; Bourne et al., 2017).

Vision specialists needs to be included in interdisciplinary stroke care

One of the greatest improvements in stroke management has been the implementation of interdisciplinary stroke units in acute care (Langhorne et al., 2020). The interdisciplinary approach has significantly changed the outcomes for stroke survivors and reduced mortality rates (Feigin et al., 2021). These teams consists of professional disciplines covering medical, physical, cognitive, and mental functions (Langhorne et al., 2020). However, professionals with vision expertise are not traditionally an integrated part of the interdisciplinary stroke team (Feigin et al., 2019) or included in the patient pathway, even if there are a few exceptions in both Norway and Sweden. Another barrier is that health care and adult education services for stroke survivors are governed from different directorates, laws and regulations.

A first and essential step in improving vision care after stroke is to assess and identify visual problems in stroke survivors, and adapting international research and good practice is both important and feasible. In Norway, many stroke and rehabilitation units have implemented the "KROSS" vision tool (Falkenberg et al., 2016; Mathisen, 2022) in their services. The KROSS tool is used to identify the presence of vision problems including reduced visual acuity, central and peripheral visual field loss, oculomotor problems and reduced visual attention. KROSS is similar to the VISA tool developed in the UK (Rowe, Hepworth, et al., 2020; Rowe, Hepworth, et al., 2018).

Vision and stroke need to be integrated in interdisciplinary health care education programmes

The lack of focus on vision and visual problems in the education of different health care professions is a major problem, as most stroke patients need help from many different professionals. In addition to basic vision competence, there is a need for more advanced competence for stroke professionals. The University of South-Eastern Norway offers a Nordic course in vision rehabilitation after stroke and other acquired brain damage. The 20 ECT course is interdisciplinary and has approximately 20 students per year with both health care and educational professionals, including optometrists, ophthalmic nurses, and vision education specialists. However, there is a need for a wider portfolio of educational courses to advance competence and bring much needed knowledge and collaboration within all aspects of vision rehabilitation after stroke.

Although visual impairments following stroke have recently been given more attention in research and stroke care, there is still need for more knowledge, better interdisciplinary collaboration, and more structured national and local clinical guidelines to promote equal, sustainable health services after stroke and other brain disease. Norway is a large territory with a small population with several small municipalities taking care of stroke patients. It is necessary to (re) think how specialised knowledge about vision and stroke should reach these patients. One important initiative has been the interdisciplinary Norwegian Vision in Stroke network (NorVIS) that started in 2019. NorVIS is a large national network supported by The Research Council of Norway, and consists of more than 36 partners from academia, patient and user organisations, and professionals from health care and education across disciplines and sectors. International academic researchers and vision rehabilitation service providers contribute with their expertise and experiences from UK, Sweden, Denmark and The Netherlands. The overall purpose of NorVIS is to reduce the burden of stroke by promoting research-based routines for vision assessment, care, and rehabilitation across all segments of health care services in Norway (www.synogslagnett.no). NorVIS poses as an attractive consortium partner and platform to coordinate and cooperate in developing national or international interdisciplinary education, research, and innovation to strengthen clinical practice of vision rehabilitation after stroke.

Call for papers for special issue on vision and stroke

Development of new knowledge in complex areas such as sequelae caused by stroke requires multifaceted and creative research.

SJOVS therefore want to invite a broad range of researchers from all corners of the world to submit their manuscripts to be published in open access online within the special topic vision and stroke, and brain damage due to other causes. Topics may include, but are not limited to:

- the best way of organising post stroke vision care,
- patients' perspectives of living with post stroke visual impairments,
- effective treatments and vision rehabilitation,
- interdisciplinary interventions that include vision rehabilitation,
- innovative technological solutions for vision assessment and training,
- how to raise awareness for vision issues among patients and health care personnel.

We encourage translational research, with a variety of methodologies, including qualitative, quantitative, mixed methods, or reviews to share knowledge about vision and stroke.

Torgeir Solberg Mathisen
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Comparative Evaluation of the ETDRS Visual Acuity Chart and Arclight Cloth Chart (ARCchart) for Primary Eye Care in Resource-Limited Settings

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Abstract
This study compared the Arclight Cloth Chart (ARCchart) to the gold standard ETDRS chart for visual acuity (VA) measurement in 63 participants. The ARCchart showed a limit of agreement between −0.23 logMAR and 0.26 logMAR with ETDRS values. It demonstrated 93% sensitivity, 95% CI [86, 100] and 90% specificity, 95% CI [84, 97] when used to screen for VA worse than 0.20 logMAR. Despite its potential limitations as a tool to measure subtle changes in VA over time, the low-cost, portable cloth VA chart is a valuable alternative for measuring VA in resource poor settings.

Keywords: Visual acuity chart, low cost, logMAR

Introduction
Visual acuity (VA) measurement is typically performed using a cardboard or plastic letter chart mounted on a wall. It is crucial for identifying those with reduced vision, for detecting and monitoring change in VA after optical intervention and for monitoring eye conditions. Chart design advancements have allowed more accurate VA quantification with the current gold standard for research purposes being the Early Treatment of Diabetic Retinopathy Study (ETDRS) chart (Ferris et al., 1982; Rosser et al., 2004). This utilises a logMAR progression and controls for factors that affect accuracy such as letter crowding, contrast and legibility (Bailey & Lovie, 1976; Ferris et al., 1982).

ETDRS or other logMAR equivalent charts are now widely used in high resource settings. However, accessing these charts can be challenging in low- and middle-income countries (LMICs) where the burden of disease, and consequently the need, is greatest. Electronic versions are limited by the need for electricity and hardware such as a mobile phone or a screen attached to a computer, while printed ETDRS charts are bulky, expensive, and easily damaged.

The Arclight Cloth Chart (ARCchart) has been developed as a low cost, portable alternative to traditional VA tools in alignment with several strategic healthcare initiatives promoting integrated people-centred eye care (IPEC) in LMICs (see Figure 1). This innovative chart employs a modified logMAR format with a reduced number of letters per line and fewer lines of letters compared to traditional charts. Despite these adaptations, the ARCchart maintains a similar range of letter sizes as the ETDRS chart, testing from 1.0 to −0.2 logMAR with a 0.2 logMAR step between lines at 3 metres testing distance. Each line comprises three letters, except for the 1.0 line, which has two letters. Furthermore, the chart incorporates four different "Sloan" letters (H, O, V, Z) on one side and "Illiterate Es" on the other, enhancing its versatility. A notable feature of the ARCchart is that it is printed on high-quality 17×22 cm white cloth. This design allows the chart to be folded and stored within the Arclight direct ophthalmoscope case, serving as an important part of an affordable eye diagnostic set.

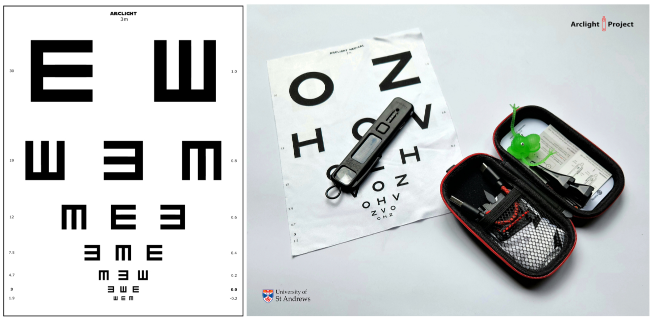

Figure 1: *ARCchart with "Illiterate Es" on one side and "Sloan" letters on the other as part of the Arclight Diagnostic Set. The chart is a 17×22 cm double-sided silk screen printed 80% polyester/20% polyamide microfibre cloth.*

While the ARCchart's novel design offers significant practical and cost advantages, the impact on accuracy of VA measurement remains uncertain. Therefore, this study aims to compare the ARCchart with the gold standard ETDRS chart to assess its suitability as a tool for routine VA testing and vision screening, as described in the World Health Organisation (WHO) Primary Eye Care Manual (World Health Organisation, 2018). By evaluating accuracy, we can determine its potential to test VA in remote and resource-limited settings. This can support the aspirations of the WHO and the International Association for the Prevention of Blindness (IAPB) to establish Integrated People-centred Eye Care (IPEC) in LMICs as part of the drive towards universal health coverage in LMICs (The International Agency for the Prevention of Blindness, 2022; World Health Organisation, 2013; 2022).

Methods
Participants
A total of 63 patients from an optometry practice in Fife, Scotland, participated in the study. The age of the participants ranged from 18 to 80 years old (mean 56.5 ± 17.9 years). They had refractive errors between +4.50 D and −5.25 D mean spherical equivalent with astigmatism between 0 DC and 3.50 DC (see Table 1). A single, UK-qualified optometrist randomly measured vision using both the ETDRS and ARCchart. Participants' VA was measured in both eyes (right eye first) using standardised instructions, asking them to read out letters from the top of the chart to the smallest letter they could see. They were prompted once if they hesitated or stopped. One measure was taken using each method. All measurements were conducted monocularly without refractive correction. The study conformed to the tenets of the Declaration of Helsinki and was approved by Glasgow Caledonian University ethics committee.

Table 1: *Participant characteristics*

Characteristic	*M* (*SD*)
Age (years)	56.5 (17.8)
Refractive error (D)	+0.20 (2.02)
VA (ETDRS)	0.41 (0.43)
VA (ARCchart)	0.40 (0.44)

Note: *n* = 63 (39 female). VA measured in logMAR.

ETDRS Chart Measurement

Participants were positioned 4 metres away from a back-illuminated ETDRS chart (luminance: 230 cd/m2, letter contrast: 86%). Responses were scored on a letter-by-letter basis, with ETDRS VA measures derived using the standard clinical method of scoring by letter (Ferris et al., 1982) rather than by line (0.02 change per letter).

ARCchart Measurement

The ARCchart measurement followed a similar protocol as the ETDRS measurement, but at a 3-metre distance. Due to the chart having fewer letters and lines, each letter had a score of 0.067 for the 3-letter rows and a 0.1 incremental change for the 2-letter row (1.0 line). Room illuminance during the ARCchart measures was 160 lux, and letter contrast was 78%.

Data Analysis

Data from both eyes (n = 126) were analysed using statistical package Jamovi (Version 1.1.9.0). The tests were two tailed with type I error set at $\alpha = 0.05$. Paired t-test was used to compare paired means. The agreement between ARCchart and ETDRS VA was examined using Bland-Altman plot (Bland & Altman, 1986), with limits of agreement calculated as ±1.96 standard deviation of the differences of the mean. To assess the sensitivity and specificity of ARCchart, the ETDRS value of 0.2 logMAR was used as the cut-off for passing or failing a screening test, corresponding to the pass/fail standard set by the WHO Primary Eye Care Manual (World Health Organisation, 2018).

Results

Paired t-test found no statistically significant difference between the mean ARCchart VA vs. ETDRS VA (0.39 logMAR vs. 0.41 logMAR respectively, p-value = 0.225). Bland-Altman plot (see Figure 2) shows that the mean difference (± standard deviation) between the ETDRS and the ARCchart was 0.01 ± 0.12 logMAR, with a limit of agreement between −0.23 logMAR and 0.26 logMAR. There was no relationship between the size of differences at different levels of logMAR VA.

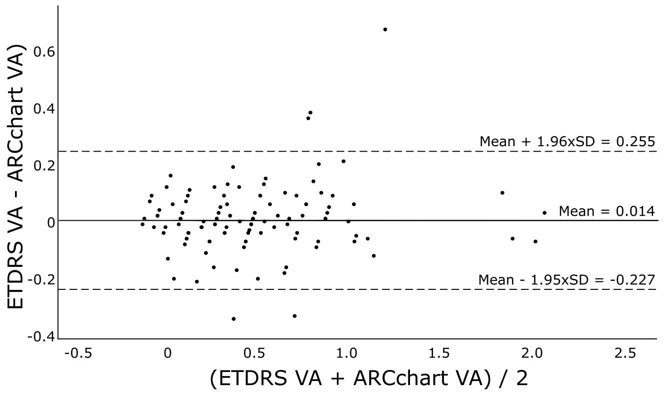

Figure 2: *Bland-Altman plot for ETDRS and ARCchart agreement. Difference in VA between the charts (ETDRS VA – ARCchart VA) plotted against average ([ETDRS VA + ARCchart VA]/2) VA values. The mean is represented by solid line and the upper and lower limits of agreements are represented by dashed lines.*

The ARCchart demonstrated 93% sensitivity, 90% specificity, 84% positive predictive value, and 96% negative predictive value in identifying ETDRS VA better than 0.2 logMAR, 95% CIs [86, 100] [84, 97] [74, 94], and [92, 100], respectively.

Discussion

The aim of the study was to validate the new ARCchart by comparing its performance to the gold standard ETDRS test chart. No significant difference was found between the ARCchart and ETDRS mean values. From a visual screening perspective, sensitivity and specificity calculations using the 0.2 logMAR cut-off used in many screening protocols suggest the ARCchart can perform well in a screening environment and will be a useful low-cost VA test for middle- to low-income countries.

The growing global need for eye care is a significant challenge for health systems. At least 2.2 billion people have vision impairment or blindness, with at least 1 billion experiencing preventable vision impairment (World Health Organisation, 2019). The WHO report "Eye Care in Health Systems: Guide for Action" advocates for IPEC as a key component of universal health coverage. IPEC aims to provide equitable access to eye care services for everyone, regardless of their socioeconomic background (World Health Organisation, 2022). In this context, the ARCchart offers a valuable, low-cost, quick, and portable solution to improving access to eye care services in low- and middle-income countries.

However, there are limitations to both the study and the ARCchart itself. Bland-Altman plot found that the limit of agreement between the two vision tests was greater (±0.24 logMAR) than reported confidence interval values (<±0.10 logMAR) found when comparing two high contrast ETDRS measures (Sánchez-González et al., 2021). This increase is likely due to the reduced sampling in terms of the number of lines and letters used in the ARCchart, which limits its use as a tool to monitor change in VA after interventions and subtle progressive vision changes due to chronic eye disease. The level of agreement between the two vision tests did not change over the range of VA measured, suggesting that the ARCchart can be used to examine individuals with reduced VA in a screening context.

The study also had some limitations, as it was performed in an optometry practice during the COVID-19 lockdown, which limited experimental control to some extent. However, consistent lighting was maintained, and the same instructions and examiner were used for all participants. To reduce recall bias, participants were asked to read the near card between monocular tests. The two charts were performed at different distances, but the small dioptric difference (≅0.08 D) is unlikely to have a significant bearing on results.

By integrating eye care into health systems and fostering collaboration across various sectors, IPEC aims to provide equitable access to eye care services for everyone, regardless of their socioeconomic background. In this context, the ARCchart offers several advantages, including low cost, independence from mobile phones, portability, and being part of a comprehensive well-established diagnostic package. These benefits make it a potentially valuable VA testing tool for low- and middle-income countries.

In conclusion, our results suggest that although the ARCchart cannot replace the ETDRS chart in controlled, well-equipped research and clinical environments it is an appropriate frugal tool for identifying patients with low vision in LMICs. This could ultimately, as part of the Arclight Package, contribute to improving healthcare delivery and accessibility in these regions, supporting the goals of IPEC and universal health coverage.

Acknowledgements

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Sammenlikning av ETDRS visustavle og Arclight tekstiltavle (ARCchart) for bruk til synstesting i ressurssvake settinger i primærhelsetjenesten

Sammendrag

Denne studien sammenliknet Arclight tekstiltavle (ARCchart) med en standard ETDRS tavle for måling av visus hos 63 deltakere. ARCchart oppnådde grenseverdi for samsvar med ETDRS målingene på mellom −0,23 logMAR og 0,26 logMAR med 93% sensitivitet, 95% CI [86, 100] og 90% spesifisitet, 95% CI [84, 97] når visus var dårligere enn 0,20 logMAR. Til tross for potensielle begrensninger ved måling av små visusforskjeller over tid, er den bærbare ARCchart tekstiltavlen et verdifullt lavkost alternativ for måling av visus i ressurssvake settinger.

Nøkkelord: Visustavle, lavkost, logMAR

Valutazione comparativa delgli ottotipi ETDRS e Arclight Cloth (ARCchart) per la misurazione dell'acuita' visiva in setting clinici con risorse limitate

Riassunto

Questo studio ha confrontato l'ottotipo Arclight Cloth (ARCchart) con l'ottotipo gold-standard ETDRS per la misurazione dell'acuità visiva (VA) in 63 partecipanti. L'ARCchart ha mostrato un limite di accordo tra −0,23 logMAR e 0,26 logMAR rispetto ai valori ETDRS. Ha dimostrato una sensibilità del 93%, IC al 95% [86, 100] e una specificità del 90%, IC al 95% [84, 97] quando utilizzato per la selezione di VA peggiore di 0,20 logMAR. Nonostante possibili limitazioni come strumento per misurare piccole variazioni nell'acuità visiva nel tempo, l'ottotipo per la misurazione dell'acuità visiva economica e portatile è un'utile alternativa in contesti con risorse limitate.

Parole chiave: Ottotipo per la misurazione dell'acuità visiva, basso costo, logMAR

Kongsberg Vision Meeting 2023: Abstracts

Kongsberg Vision Meeting was held at the University of South-Eastern Norway in Kongsberg, for the 15th time, on October 23–25, 2023. The meeting was organised as a three-day meeting with a lighting design day followed by two clinical optometry and vision research days. Rigmor C. Baraas, Helle K. Falkenberg, Ellen Svarverud, Lene A. Hagen, Gro Horgen Vikesdal, Lotte-Guri B. Steen, Hilde R. Pedersen, Helga I. Wåseth and Are Røysamb organised the three-day meeting. The theme this year was *"New Developments and their impact on the practice of Optometry and Lighting"*. Keynote speakers for the lighting design day was Alp Durmus, Pennsylvania State University (USA) and Luciana Martinez, Light Follows Behaviour (UK). Keynote speakers for the optometry and visual science days were Linda Lundstrøm, KTH Royal Institute of Technology (Sweden), Geunyoung Yoon, University of Houston College of Optometry (USA) and Abinaya Priya Venkataraman, Karolinska Institutet (Sweden). The abstracts from the other invited and contributed talks on the different days are presented in the order they were given.

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Recent developments and future of lighting research

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Abstract

Lighting technology and research have undergone remarkable advancements in recent years, revolutionising the way surroundings are illuminated. These advancements have contributed to a deeper understanding and enhanced utilisation of lighting design for humans and the environment. The keynote presentation will delve into the recent developments and future directions of lighting research, exploring the dynamic landscape of this rapidly evolving field.

The first part of the keynote will focus on the advancements in lighting technology. Solid-state lighting (SSL) has emerged as a game-changer, offering energy-efficient and long-lasting lighting solutions. The latest breakthroughs in SSL, especially alternatives to LEDs (e.g., carbon-based quantum dots, laser diodes), will be discussed. Additionally, the role of VR and AR, freeform optics, and additive manufacturing in lighting design and research will be explored.

The second part of the keynote will focus on the diverse applications of lighting research. The topics will be discussed under two parts: measurement of light and user response (wearable sensors, circadian metrics, drone measurements, light fields, lighting application efficacy), and utilisation of techniques (projection mapping, adaptive, autonomous lighting systems, digital lighting design, predictive maintenance).

Finally, drawing from past experiences, future directions in lighting research will be outlined, highlighting the importance of resource management, applied research, circular economy, and systems thinking. The keynote aims to inspire researchers, practitioners, and industry professionals to continue pushing the boundaries of lighting technology and its applications, paving the way for a brighter and more sustainable future.

Nature centric lighting and LED

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Abstract

The extent of the adverse effects on human health from prolonged exposure to LED lighting, or artificial lighting in general, is a realm we are still uncovering. While we have identified many concerning effects already, there are also unmistakable indications of other significant consequences. It is crucial to recognise that we share this planet with countless other species, and if we disrupt the biodiversity around us, we ultimately jeopardise our own well-being too.

The era of human-centric lighting is behind us; our perspective has broadened. It is no longer only about catering to human needs but has evolved to consider the well-being of the entire planet. Through our profession, we are committed to making a positive impact. Our approach now includes lighting that is bird-friendly (or more precisely, avian-friendly), marine-friendly, and, of course, considerate of human needs without being solely centred on them. It is a comprehensive approach that enables society to function during hours of darkness while making every effort to minimise the impact on other life forms.

The field of lighting design is evolving, driven by a growing understanding of how artificial light impacts biodiversity. With light pollution increasing by 10% annually, largely due to the widespread adoption of LED lighting, and mounting evidence of the harm caused by artificial light to numerous species, there is an urgent need for conscious planning of all outdoor lighting installations.

As lighting designers, it is our responsibility to mitigate the adverse effects of artificial light. This means avoiding and controlling light where it creates harm. Achieving this goal requires more in-depth research into the effects of artificial light on different species.

Incorporating darkness into specific areas should also become an integral part of our profession. It is a continual challenge to educate our clients about the importance of leaving certain spaces unlit. Evidence-based research is essential for understanding the most effective ways to tailor solutions that balance the need for light with the preservation of natural ecosystems.

Fortunately, some clients are already on board. They understand the need to protect nature from artificial light and are willing to plan accordingly. The lighting strategy for Lilleakerbyen, an urban transformation project initiated by Mustad Property, tries to shield the river from light in order to restore and preserve the rich habitat of numerous species that live along the river.

Can an old industrial site be transformed into a dynamic, walkable town that boasts all the qualities of a thriving urban environment while simultaneously preserving the neighbouring natural ecosystem?

The presentation will show the methods used to develop a strategy for lighting and darkness in Lilleakerbyen in order to care for all the living species in the area.

Practical application of new developments in LED light sources and optics and rendering software

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Abstract

In this talk I will give varied examples regarding the use of different new technologies and developments in the field of lighting technology and software from my practice as senior lighting designer for Oslo Municipality, Henning Larsen Architects and Asplan Viak. My talk will include a case study of restoring the heritage lighting for the royal castle square in Oslo, and an impact assessment regarding light pollution and spill light for a nature conservation area in Bergen. I will also demonstrate new possibilities regarding the use of real time rendering software as a practical tool for lighting designers, and a showcase study in glare reduction by the application of recent developments in optical technologies for exterior LED lighting fixtures.

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Positive or negative health outcomes

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Abstract

New LED-technology has given us opportunities to create almost any spectrum of light, and in recent years researchers, clinicians and manufacturers have enthusiastically created new solutions for the application of light in medical treatments, diagnosis of pathology, and use of "healthy" lighting. We know that light has profound effects on health and well-being, notably on conditions linked with circadian rhythms. To be scientifically correct, claims of health effects must be supported by research. Since light is only one of many factors influencing our health, observational studies may be difficult to interpret. There are certain quality criteria that should be fulfilled, among them is the use of appropriate controls depending on study design. Furthermore, effects should be plausible, e.g., a mechanism may be identified with some degree of scientific certainty and a dose-response relationship should be demonstrated. Absorption of light in the eyes or skin is of importance, because no effect of light can take place without absorption of photons in chromophores, either pigments in the eyes or natural absorbers in the skin, like precursors of vitamin D.

General lighting may support well-being, but as soon as one applies light in diagnosis and treatment of disease there are many legal requirements that need to be fulfilled. Among the requirements are involvement of health professionals and restrictions on marketing of medical treatment, also in the frame of alternative medicine. Examples will be provided and discussed.

Adaptive Road Lighting

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Abstract

Comlight AS is a Norwegian company established in 2007, which has become world leader in adaptive dimming of road lights. The plug-in node Comlight Eagle Eye Zhaga was launched in 2020 and won 1st prize for "Best use of Zhaga-D4i" in 2021. Our detectors are being marketed in Europe, Australia, Asia, and South America.

Benefits of adaptive dimming:

- Reduced energy consumption
- Reduced light pollution
- Enhanced safety

Energy and sustainability are topics of high interest especially in the Western world. Cleaner energy sources and reduced consumption are targets to be met to reach climate goals. For European cities and highways, the electricity spent on road lighting is substantial. The exact numbers vary in the EU, but we have seen claims as high as 40% of the total consumption for some local municipalities.

The interest in light pollution varies around the world. In Norway there is research on the effect on insects and in Sweden the negative effects on bats are being studied. In North America DarkSky International has become an authority on combatting light pollution.

Well-lit roads save lives. In the search for reduction of energy the most frequently used alternatives are MidPointDimming (MPD), adaptive dimming, or turning the light off completely at night. MPD is a cost-effective solution since most luminaires sold today can have this software installed. Adaptive dimming gives full effect upon detection and dims down seconds later to save energy. From a safety perspective adaptive dimming is the best option.

Comlight Eagle Eye detectors are mounted on the pole or directly on the luminaire with a Zhaga socket. The Doppler radar provides one solution for all when detecting both slow pedestrians and fast cars. When detecting an object, the unit will make the luminaire increase the effect to a given maximum level, often 100% effect. It will also alert preset neighbouring units so they also give the maximum effect. When the object is detected by the next unit, radio signals will be sent again. This is how Comlight makes a 1-1 light wave in front of a moving object. The road ahead will always be safely lit.

When the object has passed, the detector will start its countdown and after a few seconds make the luminaire dim down, often to 20% effect. The result is a light wave also behind the object. This light wave adapts if the object's speed increases or decreases.

The Comlight Doppler radar differentiates between slow- and fast-moving objects. A fast car triggers more lamps lit up to maximum effect ahead of it, while a slow pedestrian triggers fewer lamps ahead. The effect is held for a longer period for the pedestrian and shorter period for the car.

For 2-way communication to and from the installation, one or more gateways with 4G mobile SIM card is used. With gateway it is easy to change parameters or harvest statistics and diagnostics.

The powerful effect of light

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Abstract
Research in chronobiology has shown us how important light/dark cycles are for our circadian rhythm. With the right light settings during the day, we will be able to improve the quality of sleep.

Research has also shown us that light can help improve our performance, although the research on light still will require more field studies to underline the effect. But researchers at University of Bergen have done a very interesting study with significant results on how light can improve the working condition for night shift workers.

We at Glamox have incorporated knowledge on the non-visual effects of light into our Human Centric Lighting concept since 2013. The research done within the field has defined four parameters we have to have control to enable design of a lighting solution that takes the non-visual effects of light into account.

In my presentation I will go through three interesting studies to which Glamox has contributed. I will present the design parameters for the successful design of a lighting system that takes the non-visual effects of light into account in the best possible way.

User Participation Processes and Sense of Place from a Sociological Perspective

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Abstract
Public spaces are vital components that influence the everyday experience of our towns and cities, yet they are also some of the more complex spaces to design to benefit their diverse range of users. To light a space in one way rather than another influences and shapes how it feels and is experienced by all the people who inhabit it. This raises key questions such as: "who are we designing for?" and "for what purpose?".

While the physical design of a space can be easily communicated to the general public in terms of design elements (seating, playgrounds, trees and planting), lighting is still very much unknown territory and very much imposed on the general public. It is also a complex topic to discuss with non-lighting professionals with key terms that need to be deciphered before beginning any conversation.

The lighting profession additionally has various guidelines and, at times conflicting, best practice approaches related to wellbeing, ecology, light pollution, energy efficiency, safety and security among others. And while following these guidelines can lead to technically and aesthetically successful lighting projects they also need to work on a social level. They need to support and improve people's quality of life and interactions and address any root concerns or issues. For this to happen, there needs to be a shift in the design approach of lighting that values and recognises the social aspects of lighting as equal to the aesthetic and the technical.

The fundamental starting point is to understand the place one is designing and the users of the space, the activities happening and not happening, the impact the seasons and time of day and night have and the bigger role of the space in the local context. This approach can then inform how user participation can be implemented to the fullest potential in a manner that meaningfully informs the design and the research focus, and most importantly brings communities into the design process for the long term.

Mechanisms of optical interventions for myopia control

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Abstract
The prevalence of myopia increases rapidly worldwide, and the World Health Organization estimates that half of the world's population will be myopic by the year 2050 if no treatment is developed soon. The eye health field is therefore working intensively to find strategies to prevent the progression of myopia. Today, several different myopia control interventions are in clinical use. However, the underlying treatment mechanisms of these interventions are still unknown, and the treatment effect is only partial. This presentation will review current optical myopia control interventions in the form of spectacles and contact lenses and compare their optical characteristics. These interventions are often designed to introduce myopic peripheral defocus. However, their effect varies between individuals and goes beyond defocus; other proposed mechanisms include accommodation, retinal contrast, and asymmetries in peripheral optical errors. To gain further understanding on how the treatment efficacy can be improved, it is therefore important to also assess the depth of focus and the retinal image quality with the optical interventions.

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Accommodation and phoria in myopia control

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Abstract
Myopia is on the increase worldwide and is reaching pandemic numbers in some parts of the world. The research into understanding the aetiological factors causing the observed increase of myopia, and to find treatment options towards stagnation of myopia is extensive.

In the Nordic countries the distribution of refractive errors is different than other parts of the world, with a modest proportion of youngsters developing myopia. An increase in myopia is, however, concerning particularly due to the increased risk of sight threatening pathology, and myopia control should be mandatory in a modern optometric practice. There is extensive evidence of the benefit of applying myopia control to slow the progression of myopia.

Various features of binocular vision (BV) may be related to the progression of myopia. Research has indicated that some factors may be predictive of myopia progression, some may have causative effects, and some may even influence outcome and predict the response to some treatment options.

In this presentation the rationale and importance of testing

binocular vision in patients that go through myopia control will be discussed.

Applying the NorDSam learning model to flexible education of Norwegian optometrists

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Abstract

NorDSam's learning model for flexible continuing education has been developed in collaboration with the optometry profession and optometry education in Norway, Sweden, and Denmark. The purpose of this model is to provide long-lasting learning outcomes for professionals and to equip them with lifelong learning skills, enabling evidence-based practice.

The model has been initially implemented in a continuing education course focused on effective and efficient patient referrals in optometric practice. The course has been successfully delivered twice, attracting a total of 20 optometrists with varying levels of experience and training. All courses have concluded with comprehensive course evaluations to gather feedback for improvement.

The learning model will be presented in comprehensive detail, accompanied by a summary of experiences gained from the completed courses. Additionally, a plan for further development and implementation of the model will be discussed.

Design of a cohort study on myopia development in schoolchildren in Stockholm

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Abstract

In recent years, near work and peripheral image quality have gained increased attention as contributing factors to myopia development. However, it is not yet understood what aspects of the peripheral image quality affect myopia progression, or what parts of the periphery are the most susceptible. Furthermore, as accommodation itself changes the peripheral image quality, near work tasks should be included when assessing peripheral image quality and its effect on myopia progression. This is the basis for a new study on myopia that has just been launched in Stockholm as a collaboration between KTH Royal Institute of Technology and Karolinska Institutet. The aim of the study is to identify optical biomarkers that affect myopia progression in children, with a unique focus on peripheral image quality during accommodation.

The study is a prospective cohort study on myopia that will follow schoolchildren longitudinally for up to eight years, with measurements every 6-12 months. Up to 80 children aged 6-9 years at baseline are to be included in the study. The children are recruited from schools and optometrists in the Stockholm area, and the first subjects were measured in September 2023. Measurements include:

- Eye examination and vision tests to ensure normal ocular health and normal monocular and binocular vision.
- Questionnaire to assess environmental factors, e.g., time spent outdoors, time spent on near work, and parental myopia.
- Simultaneous wavefront measurements in the foveal and peripheral field (±25°) of the right eye, using a custom built dual-angle wavefront sensor. The subject fixates binocularly on a Maltese cross target placed at either 0.22 D or 5 D accommodative demand. This allows measurement of:
  - Relative peripheral refraction at different levels of accommodation.
  - Foveal and peripheral image quality at different levels of accommodation.
  - Accommodative lead or lag.
- Cycloplegic autorefraction (cyclopentolate 1%)
- Axial length
- Corneal curvature
- Retinal OCT

An example of baseline results from the first subjects will be presented.

Acknowledgements

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The association between vision anomalies and academic attainment in children

Tina R. Johansen, Hilde R. Pedersen, Rigmor C. Baraas, Trine Langaas*, The SNOW Study Investigators

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Abstract

Vision is the most important sensory input for children to learn and to reach their academic potential. This relates to both sensorimotor and cognitive function (Hill et al., 2022; Utdanningsdirektoratet, 2018) known to impact on their academic attainment (Bjørset et al., 2022). The final systematic vision assessment carried out in Norwegian children is at 4–5 years of age (Mavi et al., 2022). Whether a child receives an eye examination closer to starting school or during the school years up to the age of 18 rests on the child's parents'/guardians' knowledge about the importance of good eyesight for proper learning. Socioeconomic status may play a role, whereupon informed carers are more likely to bring the child for an eye examination and to follow up advice given, ensuring prescribed correction is worn if needed. Up to four in ten school aged children have an untreated visual condition (Hagen et al., 2018; Kulp et al., 2022; Sandfeld et al., 2018), and in Scandinavian children and adolescents, hyperopia is the most prevalent vision anomaly (Demir et al., 2021; Hagen et al., 2020; Hopkins et al., 2020). Left uncorrected, it may impact on academic attainment (Falkenberg et al., 2019; Flodgren & Ding, 2018). To detect hyperopia (and to make sure myopes get the correct prescription), cycloplegic refraction is necessary (Niechwiej-Szwedo et al., 2017).

The SNOW study obtains measures of eyes and vision (including ocular biometry and cycloplegic autorefraction) every year for children attending 2nd, 5th and 10th grade (corresponds to age 7–8, 11–12 and 15–16 years), at four schools in Kongsberg municipality. To assess the children's sensorimotor and cognitive function, we use a computer-based tablet with a set of standardised visuomotor and cognitive tests, using a stylus or their finger as an input (Birch & Kelly, 2023). The results from the vision assessments are compared with sensorimotor and cognitive function. The next steps involve analysing the results from the

national compulsory tests ("Nasjonale prøver"; The Norwegian Directorate for Education and Training, Norway (Roch-Levecq et al., 2008)) in reading, maths, and English to investigate the relationship between uncorrected vision anomalies in primary and secondary school and academic attainment.

Our findings may further emphasise the importance of assessing children's vision during school years, to understand how it may impact on their learning trajectories and potential in the future.

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Extended reality in optometry education

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Abstract

Extended reality technology has emerged as a promising tool for education, enabling experience-based learning through digital simulations. At the University of Latvia, students enrolled in the master's programme in clinical optometry use this technology, specifically the Eyesi indirect ophthalmoscope simulator, to enhance their ophthalmoscopic skills. This training has resulted in positive learning outcomes and has been well-received by students, serving as a valuable addition to their traditional clinical practice. However, it has also presented certain challenges. Notably, some students have reported experiencing asthenopic symptoms following their training sessions. This has fuelled our scientific interest and motivated us to gain a deeper understanding of the underlying causes of these issues.

Currently, at the Department of Optometry and Vision Science, we are investigating how the human visual system reacts to various extended reality technologies. In this presentation, I will share the findings from the ongoing study, focusing on elucidating the effects of a 40-minute training session using the indirect ophthalmoscope simulator on visual functions and user comfort among master's students. Additionally, I will discuss these results in the context of the considerations required when integrating extended reality tools into optometric education.

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Wavefront-guided Individualized Vision Correction

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Abstract

Ocular wavefront sensing has revolutionised our understanding of the optics of the eye and the limitations of human vision. This technology not only allows us to objectively measure optical defects in the eye (i.e., higher order aberrations), but also to correct the aberrations by using advanced vision correction methods including adaptive optics, customised ophthalmic lenses, and surgical procedures. Studies have demonstrated that correcting higher order aberrations significantly improves visual performance compared to conventional refractive error correction. The visual benefit is even more substantial in patients with pathologic corneal conditions such as keratoconus. My talk will focus on the principles and key factors of wavefront-guided vision correction, and recent advances in making the technology clinically applicable. I will also introduce custom, wavefront guided presbyopia correction, and discuss fundamental insights on how prolonged visual experience with the native optics alters neural processing.

Artificial Intelligence and Machine Learning Algorithms in Optometry

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Abstract

Artificial intelligence (AI) is becoming increasingly available in many areas of eye care. AI is a broad term that covers any technology that simulates intelligent behaviour and critical thinking comparable to a human being. Machine learning (ML) is a subset of AI where the computer can learn from data with or without human intervention (deep learning) for optimisation. The wide-ranging use of multi-modal digital imaging, and objective markers make optometry best suited for AI integration. This talk will mainly focus on the automated subjective refraction techniques and predicting subjective refraction based on objective data. Developments in AI in other areas within optometry such as contact lens fitting, myopia development, and diagnosis of ocular diseases will also be reviewed. The strengths, challenges, validation, and limitations of AI in optometric practice will be discussed.

Limit values of optical radiation and application in phototherapy

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Abstract

The purpose of this presentation is to make users of optical techniques aware that too much optical radiation can cause damage. Therefore, limit values of exposure of skin and eyes are implemented according to international guidelines. All limit values are expressed in units determined by the relevant biological endpoint and represent a dose below which exposure cannot cause a harmful effect. It is exactly such biological damage that is intended in most forms of efficient phototherapy, but at doses and exposure conditions beyond the limit values. The use of photosensitising drugs may increase the light-induced effects in e.g., photodynamic therapy.

Legally, the use of optical radiation on patients is exempt from the limit values, because if you stay below the limit values, the dose will be too low in most forms of phototherapy. To be eligible for such an exception, the practitioners must meet certain requirements for medical competence. The use of light treatment for circadian rhythm disturbances may, on the other hand, occur with relatively low irradiance from light sources with a large area (for example, the blue sky) and at doses that will not violate the limit value for blue light retinal hazard. For radiation workers (yes, light is radiation, and light designers, optometrists and ophthalmologists may be regarded as radiation workers), bystanders and the general public the limit values apply.

In conclusion, everyone who works with radiation, and especially with advanced techniques on patients, should be aware of the limitations that apply. They must know about physical units, doses and spectra and be able to protect themselves, their colleagues, and their patients.