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Poster abstracts

Poster I

Light and Migration from Latin Americans to Germany

Author

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Abstract

The present research paper is focused on the topic of daylight in the life of the Latin American migrant community residing in Germany and how they experience the change in daylight conditions from their past experience in their home country to their present and new experience in their new country of residence. There is very little information on research studies concerning this topic and no reference study on how to do lighting design projects with an approach for designing for people who is experiencing a change in daylight conditions due to its mobility experience of migrating from one place to another.

It is a non-experimental, inductive, transversal, and exploratory study that seeks to delve into the problematic of daylight dynamic property according to the geographical locations around the world and the dynamicity of people who migrate from one place to another. In this research study I present the case of the Latin-Americans who migrate to the country of Germany; and more specifically are residents of the capital city of Germany: Berlin. Which has the biggest percentage of foreigners in all federate states; as well as been considered as a multicultural city with people with diverse migration backgrounds. (Geis-Thöne, 2023)

The main method for gathering data was the implementation of an online questionnaire with mixed quantitative and qualitative survey techniques. In addition a method of memory and expressive writing was employed for gathering the expressions of Latin Americans that live in the city of Berlin.

The analysis of this questionnaire is wide and the main findings result in the awareness that the respondents have considering the change of daylight conditions from a region to another.

About the results of this research study; the respondents are very much aware of the positive influence of daylight back in their home countries, and report being more aware of is that daylight affects them mentally and physically when experiencing the daylight conditions of the city of Berlin and write also on considering more the importance of daylight in their mental and health wellbeing.

Interestingly is the report on strategies that helps respondents to minimize the effects of the process of adapting to other daylight conditions. Some of them take action on creating a comfortable environment that might remind them their past daylight conditions in their home countries.

Another special finding was that Latin American participants to this research studies are highly aware of the seasonality and daylength effect of daylight conditions in the city of Berlin. This gives an important cue to further research studies and possible architectural lighting design

solutions on how to mimic and create similar daylight conditions to help people transition better the adapting process to the actual geographical location and residence of people.

My personal conclusions are that this research study gives a wide panorama of topics related to the phenomena of migrating and adapting to daylight conditions so that humans can adapt better and fulfill their mental and health well-being necessities with the help of lighting design strategies.

The approach on the matter can be diverse, and it is very important to include the psychological and cultural factors for making more complete architectural lighting designs.

Keywords: daylight, migration, culture

Poster II

The Photon Space: preliminary data from a research site to study the effect of daylight on human volunteers at northern latitude

Authors

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Abstract

Daylight was used for centuries to prevent and cure human diseases. But it has dropped out in modern times despite its enormous benefits for a healthy brain. The precise mechanisms through which light exerts its diverse effects is difficult to address experimentally in human subjects and key aspects have remained poorly understood. The Nordic Daylight Research Facility, so-called 'Photon Space' is an all-glass thermally well insulated suite located just 2.3° (257 km) south of the polar circle. Its location on a meadow of the ecological destination for nature tourism in Granö Beckasin, seldom any artificial light allows us to measure a wide range of natural light qualities throughout the changing seasons, and study its effects on human physiology and behaviour. Apart from transmitting natural light, the Photon Space is equipped with controllable electrical lightning to study the effects of artificial light of different parameters on retinal sensitivity, sleep, mood and subjective experience. We will present our protocol together with preliminary data from the indoor habitat and our participants. In this 2.5 week long study protocol the participant sleep/activity rhythm and light exposure is recorded continuously using actigraphy. After one week of baseline recording in their home setting the participant spends 72 hours in the Photon Space, where multimodal data are sampled regularly during morning and evening twilight and daylight conditions, as well as under pre-selected and self-selected electrical light. Apart from subjective questionnaires and scales, wearable devices such as an actigraph, a wrist-worn diary, pupillometer with eye tracker and an electroencephalograph are used for data collection. The interior milieu conditions in the habitat are captured using a variety of sensors including a photo-spectrometer and multi-sensor recorders to capture Illuminance, UV, humidity and temperature. The Nordic Daylight Research Programme aims to fill a wide gap in our knowledge on basic questions related to sleep and mood regulation by daylight. It provides information to re-evaluate lighting regimes for the Nordic habitats with long twilight phases to be accounted for in local architecture and lighting designs.

Keywords: Daylight, Twilight, Photoperiod, Sleep, Subjective experience

Poster III

Realization and Performance Characterization of Luminescent Lightshelves

Authors

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Abstract

Lightshelves have shown considerable potential in increasing internal daylight and reducing energy usage in the form of artificial light. Previous research to assess their performance, has focused on analysing their impact on visual aspects, such as on work plane illuminance, however there is limited research that evaluates their impact on non-visual effects of light. The non-visual effect of light has been shown to trigger a set of circadian and sleep-related biological responses (e.g., hormone production, alertness) that are dictated by the wavelength and intensity of the light. Within the eye, the photoreceptor for non-visual effect has a higher sensitivity to short wavelengths, with a peak sensitivity within the blue range of the visual spectrum around 480 nm. Therefore, a luminescent lightshelf with a spectrum-shifting feature may redirect the natural daylight deep into the room and enhance the non-visual effect.

This research aims to develop a systematic experimental method to characterize the daylight performance of luminescent lightshelves with measurements. The experimental method will be carried out in a modified cabin unit to find out the timing difference in circadian-related performance between a conventional lightshelf, a luminescent lightshelf, and a control group with glazing under different outdoor weather conditions. Factors such as wall colour, view orientation, and glazing types are considered to evaluate their effects on the interior luminous environment, therefore on the occupant's visual field. In addition to the characterisation of the lightshelf, the experimental data is also used to inform and optimise the design of the luminescent lightshelf and validate simulation models of the operation of lightshelves.

Keywords: Daylight, Test Unit, Luminescent Lightshelf, Non-visual Effect, Circadian Rhythm.

Poster IV

Sunlight Autonomy for Sustainable Buildings and Cities: Maximizing daylight potential outdoors and indoors

Authors

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Abstract

Daylight, both outdoors and indoors, is essential for human well-being. However, daylight provision often faces challenges in various climates and locations, due to factors such as shortcomings in regulations, urban densification, deregulation or special exemptions, and the limitations of existing daylight and sunlight evaluation methods. To address these issues, we propose the Sunlight Autonomy, a novel methodology and set of metrics, that aims to overcome the limitations of existing early-stage daylighting metrics and is valuable for urban planning and architectural design purposes.

Keywords: Sunlight, daylight, EN 17037, annual daylight metrics, solar access

Poster V

Natural daylight during office hours improves glucose control and 24-hour substrate metabolism in type 2 diabetes patients compared to constant artificial lighting

Authors

Jan-Frieder Harmsen (presenter)[1,2] / Ivo Habets[1] / Marit Kotte[1] / Dzhansel Hashim[1] / Soraya de Kam[1] / Gert Schaart[1] / Anne Gemmink[1] / Marijke Gordijn[3,4] / Patrick Schrauwen[1] / Charna Dibner[5] / Joris Hoeks[1]

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Abstract

Background: 90% of our time is spent indoors and during daytime we are exposed to lower light intensities and a different color spectrum compared to natural daylight. This chronic lack of daylight is increasingly being considered as a risk factor in society's rising incidence of metabolic diseases, such as type 2 diabetes (T2D), since light is the main time cue for our circadian time-keeping system. Here, we investigated the potential benefit of increased natural daylight exposure compared to constant artificial lighting on 24-hour glucose control and substrate metabolism in T2D patients.

Methods: Thirteen T2D patients (70±6 years, BMI: 30.1±2.3 kg/m2) were exposed to two lighting interventions of 4.5 days in a randomized cross-over fashion: natural daylight facilitated through windows versus constant artificial lighting (photopic illuminance: 300 lux, melanopic EDI: 209 lux) during office hours (8:00-17:00h). Between interventions there was a washout of at least 4 weeks. Evenings were spent in dim light (<5 lux) and the sleeping period in darkness (23:00-7:00h). Volunteers were provided with standardized meals and wore continuous glucose monitors (Abbott, Freestyle Libre Pro iQ) on their upper arm. On day 4, indirect calorimetry was performed around the clock (every 5 hours) to assess 24h substrate metabolism and energy expenditure together with frequent blood draws to assess circulating metabolites. On that evening, saliva samples were collected every 30 min from 19:00 to 23:00h to determine dim-light melatonin onset (DLMO). Core body temperature was measured using a telemetric pill. On day 5, a fasted muscle biopsy was taken to assess clock gene expression, and a mixed meal test (MMT) was executed, for which frequent blood samples were taken in conjunction with indirect calorimetry.

Results: Volunteers spent more time in the normal glucose range (4.4-7.8 mmol/l) upon natural daylight, accompanied by a lower respiratory exchange ratio throughout the 24-hour cycle, indicating a shift towards fat metabolism in the natural compared to the artificial light condition. Salivary melatonin levels were higher in the late evening (22:00-23:00h) upon natural daylight, but DLMO was not different between conditions. mRNA levels of *Per1* and *Cry1* in skeletal muscle were higher upon natural daylight. Following the MMT, the respiratory exchange ratio was lower upon natural daylight.

Conclusion: Our findings suggest that facilitating natural daylight exposure during office hours has a positive impact on metabolism and could support the treatment and prevention of metabolic diseases.

Keywords: daylight, glucose control, clock genes, melatonin

Poster VI

Biometric Architecture: Impact of Available Daylight in an interior environment on Photoentrainment of the circadian system

Authors

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Abstract

Daylight plays a central role in human health and wellbeing. Over 3.5 billion years life's rhythms on earth have evolved in direct response to the temporal availability of daylight. Referred to as circadian rhythms, all our daily physiological and behavioral rhythms attune with the 24-hour light/dark cycles through the process of photoentrainment. Disruptions of these rhythms are associated with numerous acute and chronic, behavioral, mental, and physiological disorders which include some life-threatening and chronic diseases.

In the industrialized world we spend more than 90% of our lives within the built environment with profound impacts on our health. Daylight had played a formative role in the creation of architecture prior to the advent of electric light, about 140 years ago. Considering lighting, most interior spaces are designed to promote adequate visual comfort and task performance to the detriment of the non-image forming effects. Today, most interior spaces are dimly lit during the day for a clear signal for photoentrainment of the circadian system while at night the same light levels have proven to have suppressive impact on the secretion of melatonin which is one of the main biomarkers for timing of the circadian system and sleep. Untimely light signals and lack of clear contrast in spectral power distribution and illuminance levels in our current light environment can have adverse effects on the timing of sleep and circadian rhythms causing a quantifiable desynchrony. There are two major questions here:

1. What is the optimal timing, duration, intensity, and spectral power of daylight needed, within the built environment, for a robust photoentrainment of the circadian system?

2. Are current regulated quantities of interior daylighting by national and international building codes sufficient for a robust photoentrainment of the circadian system?

A major indicator of human circadian timing, melatonin, is expressed in response to a signal from the suprachiasmatic nucleus (SCN) in dim light or dark conditions. Located in the hypothalamus, SCN is the body's endogenous zeitgeber receiving direct signals from intrinsically Photosensitive Retinal Ganglion cells indicating the environmental light conditions. Dim Light Melatonin Onset (DLMO) is recognized as the most reliable tool for assessment of the circadian phase response to the environmental light stimuli.

Objective: The goal of this study is to investigate whether the available daylight in a modern light-filled interior is sufficient for the brain's regulation of the circadian system through the process of photoentrainment. Quantification of available interior

daylight and optimization for timely and robust circadian photoentrainment, alertness, and vigilance are of extreme value to the future practice of architecture, neuroscience, chronobiology, and environmental health. Quantifiable and reliable biomarkers such as DLMO in respond to the temporal light conditions within the built environment can help architects design optimal spaces for human habitation.

Methods: We are measuring DLMO in 13 adults to assess the timing of their circadian phase response before and after a major daylight intervention in their existing living situation where they would be observed for two periods of 3 days each under a controlled light environment. The participants would follow their normal daily social, work, feeding, sleep schedule with the exception that they would remain indoors until sunset when they can go outside using blue-blocking or virtual darkness glasses. Participants would be observed for two 3-day periods in two different daylight conditions. On the first 3-day period they are observed under their existing daylight environment which is analyzed and recorded as the base condition. There would be a major daylight intervention at the beginning of the second 3-day period, whereby all the daylight apertures will be reduced in size to provide a daylight factor closer to 2% mandated requirement from building authorities in Norway. The participants would be wearing an Actigraphy watch and a radiospectrameter to gather continious periodic data on their sleep and light intake.

Hypothesis: Due to lack of a robust light/ dark cycles i.e., the dim available daylight during the day in conjunction with bright electric light at night, most interior environments today can have a phase delaying impact on human circadian rhythms which can cause disruption in sleep and circadian rhythms.

Keywords: Daylight factor, photoentrainment, DLMO, circadian rhythms

Poster VII

Ziezo: An Interplay between Daylight, Shading and Energy

Authors
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Abstract
Windows are crucial elements that provide occupants with adequate daylighting, maintain their visual comfort, and create a connection between inside and outside. Ziezo is an insulated glazing unit that integrates solar shading with bifacial photovoltaics. This window aims to mediate between achieving high performance in daylight and shading, thermal comfort, visual connection, and energy generation. Aside from the typical electricity generated by pv as the sun faces the front side of the solar cell, the novel contribution of this window is that as part of the light is admitted through the window, it is reflected off the venetian blinds and redirected to the back side of the solar cell to contribute to additional electricity harvesting. Intricate interdependencies between system components play an instrumental role in the interplay between daylight and energy. My project aims to design a model and a tool for the optical system of Ziezo. A model which captures the physical phenomena of transporting daylight through a complex fenestration system, with respect to dynamic daylight conditions and window orientations. The optical behavior of the system are modeled in Radiance, and two interactive parametric tools have been developed to inform architects on how light interacts with complex fenestration system, visualize BSDF and specular optical characteristics by raytracing. The Ziezo project is carried out in collaboration with Pilkington BV, TNO and W/E adviseurs. The project is supported by Topsector Energy of the Dutch Ministry of Economic Affairs.

Keywords: Venetian Blind, Radiance, BSDF

Poster VIII

Working with the Sun, Daylight, & Plants for Locally-Adapted, Sustainable Living in Vanuatu

Authors
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Abstract
Indigenous societies practice robust and ingenious strategies for living sustainably and living well, developed over generations of interaction with their local environments, though they are not always without environmental conflict. In Vanuatu, a diverse archipelago of 300,000 people speaking over 130 languages, many of these practices involve considerations of the Sun and Daylight, while people continue to engage minimally in monetary and industrial economies. In this poster, we present time-reckoning, architecture, and agriculture as Daylight-mediated practices that ni-Vanuatu use to lead healthy and sustainable livelihoods. Our results are supported both by in-person interviews in Vanuatu and by a comprehensive literature survey of Pacific ecological time-reckoning systems. Vanuatu's traditional practices offer some nuance to the discussion of sustainable development as it pertains to Indigenous peoples: many practices already achieve the goals of the UN SDGs and attempts at introducing outside concepts of development must work conscientiously with these practices to avoid potential harms.

Keywords: Vanuatu, ecological calendars, ethnobotany, vernacular architecture, sustainable agriculture

Poster IX

Exploring Directions to Improve Swiss Building Legislation for Enhanced Daylighting Without Compromising Energy Efficiency

Authors

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Abstract

Given the substantial impact of buildings on global resource consumption, there has been a significant emphasis on improving energy efficiency in this sector through building regulations. This focus on energy savings, particularly advocated through urban densification and reduced thermal exchangesthrough the envelope, however, often compromises indoor environmental quality (IEQ)and therefore also human healthby limiting interactions between the building and its surrounding environment to minimize energy losses.

Our research, by examining case studies typical of Swiss buildings that adhere to regulated norms, on their energy efficiency and four key aspects of IEQ, identifies daylighting as a notably deficient aspect of IEQ in a standard Swiss office building.While building apertures are the main source of access to daylight in a dense urban neighborhood, in the current regulated state, the opening to opaque part percentage and visible light transmission are often compromised to enhance thermal efficiency and reduce the need for space conditioning, particularly heating in buildings.

Subsequent research will therefore focus on fenestration systems that can achieve higher visible light transmission with minimal heat loss, and on integrated solar envelope systems that support small-scale energy production through the building envelope tooffset a portion of the building's energy demands. This enables greater flexibility in designing openings in the building envelope without compromising thermal efficiency. Our research, highlighting the often-overlooked trade-off between energy efficiencyand IEQ in building legislative frameworks, will hence focus in subsequent phases on technological interventions that can reconcile the need for energy efficiency with IEQ considerations, aiming to inform and refine the existing legislative framework governing building practices.

Keywords: Legislative framework in construction, Energy efficiency, Indoor Environmental Quality (IEQ), Daylighting deficiency, Fenestration and solar envelope systems

Poster X

Spectral variations and pupil size in real-world environments illuminated by artificial light and daylight.

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Abstract

The light received by the human retina is altered by physical filtering and reflection, from large scale entities such as vegetation, buildings, and surfaces in our environment, to small scale structures such as the properties of the cornea and the pupillary light response. Human visual and non-visual processing of light has evolved under daylight conditions, but the lighting environment has changed dramatically to include artificial light sources with very different spectra. While patterns of daylight, mixed, and artificial light exposure in humans have often been studied using illuminance sensors, there is a lack of studies using high-resolution spectrometers to gain insight into the spectral properties of light in everyday environments.

Here, we present high-resolution spectral data measured alongside pupil size under dynamic, real-world conditions, including daylight, artificial light, and mixed light in a large age-diverse sample. We integrated a portable infrared eye tracker (Pupil Labs GmbH) with a small, calibrated, research-grade spectroradiometer (Ocean Insight). Both devices were attached to a custom 3D-printed and adjustable head mount and connected to a miniature battery-powered control computer (Raspberry Pi), allowing simultaneous sampling of 1-nm-spaced spectral irradiance near the eye level and pupil size during a 60-minute protocol in which healthy participants from a wide age range (n=83, age: 18-87 years, 51% female) performed various activities of daily living both indoors and outdoors, under natural daylight, artificial light and mixed light conditions.

The spectral composition patterns vary considerably between mixed indoor lighting and outdoor daylight, reflecting the physical characteristics of each environment. Additionally, pupil size is determined by the light level and declines with higher age. We observed smaller age effects under bright daylight conditions than under dim or moderate indoor lighting conditions. The dataset presented here provides information on the spectral diet in different real-life environments and contextualises these light spectra with physiological responses in a large, age-diverse sample.

Keywords: daylight, artificial light, real-world, spectral diet, pupil size

Poster XI

Effect of Classroom View Out on Spectral Daylight Characteristics and Myopia in Children – Preliminary Study

Authors

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Abstract

This study is a part of research that is investigating the relationship between daylighting in buildings and axial myopia in school-age children. Myopia is a common refractive error of the eye characterised by changes in the physiology of the eye that causes distant objects to appear blurry. Since the eye physiology changes notably in the first years of life until about 14 years of age before slowly stabilising, it is crucial to mitigate disruptions in this growth, particularly evident in myopic children. Myopia has become a significant health issue in school-going children and young adults and is projected to affect nearly 50% of the world's population in future years (Holden et al. 2015). This trend is pronounced in urban areas and is related to environmental, lifestyle and behavioural factors.

Research shows that time spent outdoors helps slow axial and refractive changes and helps prevent myopia in non-myopic children (He et al. 2022, Wu et al. 2018). The mechanisms of action of natural daylight as a protective factor are not yet known. According to a study by Lingham, Mackey, Lucas et al. time spent outdoors could be protective through retinal dopamine production, which is influenced by bright light. Other factors described are differences in the chromatic spectrum of light or entrained circadian rhythms (Lingham, Mackey, Lucas et al. 2020).

Humans spend almost 90% of their time indoors, where they are only exposed to lower levels of natural daylight illuminance and different spectral composition of light (Dhakal et al. 2022). Daylight reaching a window is highly dependent on outdoor environmental factors such as urban building density, street orientation, building façade materiality, presence of trees, season, sky condition and time of day. Additionally, indoor daylight availability is influenced by building design parameters such as window transmittance, window orientation, indoor material properties, volume, and position in the space (Khademagha, 2016). Myopia is more common in people living in urban environments and several studies suggest that lack of green spaces may be a significant contributing factor (Dadvand et al. 2017, Peng et al. 2021, Huang et al. 2021).

Hence, to study the impact of various outdoor environmental factors on spectral daylight characteristics indoors, particularly within school classrooms, we conducted a daylight scale model study in Berlin with different view outs. In the study, two identical scale models were constructed to represent a standard unilaterally illuminated school classroom. These models were positioned in distinct cardinal directions (east, west), facing different views (building facades, trees), with different sky view factors. Spectral daylight data was collected over a period of 1.5 months in November and December, capturing different sky conditions, times of day and seasons (autumn and winter).

The poster presents preliminary results of data analysis, focusing on the difference between the spectral daylight characteristics between overcast and clear sky conditions, for east and west cardinal directions and content of the view out.

Keywords: myopia, spectral characteristics, greenery, urban environment

Poster XII

Novel Sunlight-Powered Hybrid Pesticides for a More Sustainable Crop Protection

Authors

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Abstract

The discovery of new synthetic pesticides in the first half of the 20th century was a breakthrough in the history of crop protection. Effective pest control in agriculture prevents huge losses of food crops and is vital in a world of continuing population growth. However, the widespread use of pesticides over the past few decades has come at an enormous environmental cost due to bioaccumulation, unwanted toxicity and pest resistance. There is an urgent need for new, safer approaches to pest control. This work presents an unprecedented design of sunlight-active pesticides. The proposed idea is based on the binding of a naturally occurring photodynamic sensitiser to the molecular structure of a commercial pesticide. Two biocidal action modes are expected for these new pesticides, based on the intrinsic biochemical action of the pesticide and the photodynamic effect of the sensitizer under the sunlight. We are pleased to report that we have indeed observed a synergistic effect between the two modes of action in biological tests with Botrytis cinerea, a fungus that typically attacks grapes and strawberries. Our compound, a hybrid of azoxystrobin and phenalenone, showed an excellent antifungal activity, that was enhanced by light. This two-folded compounds offer other important advantages over previous approaches, including an improved environmental biodegradability, and efficacy against resistant strains.

Keywords: photopesticides, crop protection, photodynamic effect, phenalenone, azoxystrobin

Poster XIII

“Snail lab” - a tool to study evolution of clocks in the Arctic daylight

Authors

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Abstract

Species are shifting their geographical ranges towards higher latitudes due to changes in climate and increasing temperatures worldwide. In doing so, they encounter highly different photoperiods, which is largely responsible for synchronizing daily and seasonal rhythms. How can populations adapt to such novel light conditions? For testing this question we need to integrate principles and practices from the fields of Evolutionary Ecology and Chronobiology, an approach known as “Wild Clocks”. In our study we propose to use the copse snail (Arianta arbustorum) as a novel model species in Evolutionary Chronobiology to understand how biological clocks adapt to extreme variations in daylight via field and lab studies. We are based in Tromsø, Norway, within the Arctic Circle, in a strategic position for studying adaptation to extreme daylight. In our recently started project, funded by the Velux Stiftung, we are building the “Snail Lab” where we are breeding the snails and setting up the infrastructure for characterizing their clocks through records their activity patterns.

Keywords: colonization of the Arctic, global changes, land snails, range shifts, Wild Clocks