

DESIGNING WITH DAYLIGHT; THE RELATIONSHIP BETWEEN DAYLIGHT AND HEALTH

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Abstract

Daylight is not only fundamental for architecture and renovations, modernizations and transformations of cities and buildings - it is fundamental for people's well-being. This paper describes the significance of daylight to people. Based on a qualitative research project in Denmark in 2012 about the use of windows among 13 families I will show how daylight is perceived, used, coped with, and negotiated by people in their homes, thus exploring the social character of a natural phenomenon. A metaphor will be used from biomimetics, claiming that - like plants - the Danish participants need daylight. People's day-to-day entanglements with daylight are illustrated, highlighting the social qualities of daylight. The paper concludes that access to daylight is vital for existential reasons (health, social reasons and to feel connected to one's natural environment), showing the window as much more than a technical artefact. Based on this I argue for the window to be acknowledged as vital for creating dwelling and for its inclusion in bio-inspired design and biophilic architecture that so far have focused more on the inclusion of nature and views to greenery, less on daylight.

Keywords: Biophilic design, Daylight, Human behaviour in design, Practices, Qualitative methods

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1 INTRODUCTION

In this paper it is argued that the qualities of daylight should be more considered in building design due to its positive relation to health for the residents. The paper describes the views and significance of daylight to people in their everyday lives. The aim of the paper is to provide architects and building engineers with information about the social qualities of daylight, so that they may in building designs include these user perspectives to match the daylight needs of residents. Daylight is not only fundamental for architecture and renovations, modernizations and transformations of cities and buildings; it is fundamental for people's well-being. Being scalable, daylight is often used strategically in various types of buildings, particularly in the so-called 'health architecture' which focuses on how to increase the solar influx when designing and building houses (Hobday 1999, 2007); yet even bio-inspired design and biophilic architecture commonly focus on views to greeneryⁱ and place less attention on daylight. The reason may be found in the complexity of daylight itself: Daylight is measured quantitatively but sensed and valued qualitatively and with seasonal variations, creating challenges when building living areas aiming at as much daylight as possible through the year. Those responsible for designing and building the home, architects and engineers, rely on quantifiable ways of allowing enough daylight into buildings (or reducing it), yet people living in the homes may have entirely different views of the significance of daylight. Based on a qualitative research project in Denmark about how people use their windows, performed from May to August 2012 among 13 families, using in-depth interviews, observations, photos and postcards for storytelling, people's daylight practices will be shown - how daylight was perceived, used and coped with by these people in their homes, thus exploring the *social* character of a natural phenomenon. A metaphor will be used from biomimetics (Benyus 1997), claiming that these Danes, like plants, appeared to have a craving for daylight. With the concept of 'dwelling' (Ingold 2000), which implies that people need to engage in their environment and create possibilities for dwelling to feel comfortable and at home in the world, people's daily entanglements with daylight are illustrated, highlighting the social qualities of daylight. The paper concludes that access to daylight is vital for existential reasons (health, social reasons and to feel connected to one's natural environment), showing the window as much more than a technical artifact.

2 DAYLIGHT AND ITS HEALTH RELATION

Humans live their lives under the sun and depend on the daylight transmitted by it. This dependency exists because daylight interacts with essential parts of our natural biological system necessary for the functioning of the metabolic and immune systems in our bodies. Many enzymes, hormones and vitamins seem to need daylight to function properly. One example is the relationship between sunlight and vitamin D: Without sunlight, our body cannot produce vitamin D and a deficiency of this vitamin can cause rickets. The biological effect from access to daylight becomes perhaps particularly obvious in spring; that spring is the time for falling in love is, to some extent, also because of the increased sunlight. The light that goes through our eyes ends as electrical signals in the pineal gland of the brain. When stimulated by increased light the pineal gland sends out melatonin to areas in the brain known to be involved with feelings of love, and an increase in dopamine and serotonin appears in the body. It is precisely these neurotransmitters that many people seem to lack during the dark and long winters in the Nordic countries or in high latitude areas in general. As a substitute for unavailable daylight light therapy is recommended, artificial light with a lux corresponding to natural daylight, as a medical treatment against Seasonal Affective Disorder (also called 'winter depression') (Magnussen & Boivin 2003; Rosenthal et al. 1984, Rosenthal 2006).

The use of daylight for health or therapeutic reasons, heliotherapy, is not a new phenomenon. It has been used for thousands of years based on tacit knowledge and layman experienceⁱⁱ, but today we know scientifically that daylight has a positive influence on our efficiency and learning, as well as on our mood: Humans prefer light over darkness (Beute and de Kort 2013). Studies have shown light to have a direct effect on human health because of the way it influences the circadian rhythms (Moore-Ede et al. 1982) and a review of health outcomes of nature and daylight shows that daylight may have some stress-reducing health effect on humans (Beute and de Kort 2014). An entirely new type of cell in the human eye was discovered in 2001 and these cells send information about light intensity to the brain centers responsible for controlling circadian rhythms to patterns of light and dark, telling our

bodies when to sleep (“it’s dark!”) and when to awaken (“it’s light!”). Related research concludes that people in industrialized countries receive both too little light by day and too much light by night for optimal well-being. Daylight is rich in the blue-green area of the visible spectrum (to which the newly-discovered cells are most sensitive) and bright at the times of day that seem most important to regulating circadian rhythms. A review study focusing on the effects of daylight in residences conclude that human well-being relies on regular exposure to light and dark each day; that daylight is the most energy-efficient means to deliver the light exposure; that uncontrolled daylight also cause problems (glare from the sun reduces visibility and causes visual and thermal discomfort); that the optimal pattern of light and dark exposure - as well as the limits at which daylight control is needed - varies by race, age, and individual differences; that the desire for daylight also depends on how building openings affect the appearance of the space, on the function of the space, and on cultural norms about privacy, enclosure and view. It was further found that a view of the outdoors is also a contributor to well-being, particularly if it is a nature scene or similar pleasing sight – and that windowless spaces create monotonous conditions that may be stressful (Veitch & Galasiu 2012).

The above research on the impact of daylight on our bodies may be fairly new, but research on what constitutes sufficient daylight in a space and how to measure and predict human perceptions of glare is not. A sufficiency metric described as daylight factorⁱⁱⁱ (DF) is used for measuring daylight in a space, as a ratio that represents the amount of illumination indoors relative to outdoors at the same time. In architecture, good daylighting techniques include configuring buildings properly, elongating buildings along an east–west axis, locating critical visual tasks near the building's perimeter, bringing the light in high, admitting daylight from more than one side of a space, controlling direct sunlight, using light-colored interior surfaces, and locating workstations, TVs and computer screens perpendicular to windows (for overviews of daylighting design issues, see Evans 1981; Moore 1985; for aesthetic issues see Loe & Mansfield 1998 and Millet 1996; for daylight availability, calculation, and evaluation techniques, see e.g. Heschong et al. 1996, all references to be found in Leslie 2003). Much daylight research refers to the fact that daylit environments increase occupant productivity and provide the mental and visual stimulation necessary to regulate human circadian rhythms (e.g. Boyce and Rea 2001 in Leslie 2003), and today some research also investigates using daylight for reducing energy consumption (Sabzipour et al. 2012). At home, however, there is less need to be efficient and productive. This would almost be counter-intuitive to people’s needs for being able to dwell. Some experts say a daylit space must have sufficient daylight but not cause users to perceive glare. Additionally, some would argue that a daylit space must meet a lighting-quality or uniformity threshold. Others are more concerned that electric lighting energy savings are realized and that occupants have not disconnected the daylight sensing lighting controls. In truth, a daylit space is all of this and more. It will be argued that daylight holds social qualities which we may learn from studying what people do with daylight, when they experience too much or too little daylight, and how they think of daylight. In a daylit space, daylight is more than a sensation or a feature; it accommodates not only visual needs of the occupants allowing them to function in the space, but allows for an engagement with the environment through daily practices. People’s entanglements with daylight, their thoughts, feelings and actions, such as how to avoid glare from the sun, what they do to let daylight into their homes, their joy from seeing a sunrise from the kitchen window or feeling the warmth from sitting in a sunny window, have so far been neglected. Comparing to the above mentioned research this seems unbalanced given that a part of people’s lives and wellbeing depends on daylight and access to it. It is precisely the physical and emotional dependency combined with the large seasonal variations in the quantity of sun that make daylight important to people in high altitude areas such as Denmark (Hauge 2013b). This article thus highlights social aspects relating to the natural phenomenon of daylight.

3 THEORETICAL INSPIRATION AND METHODS

“It is a curious thing to observe how almost all patients lie with their faces turned to the light, exactly as plants always make their way towards the light” (Nightingale 1860: IX, Light)

Not only had Florence Nightingale observed that sunlight seemed to attract the attention of her patients, she also saw positive effects of it, making her refer to the sun as a sculptor: *“It is the unqualified result of all my experience with the sick, that second only to their need of fresh air is their*

need of light; that, after a close room, what hurts them most is a dark room. [...] People think that the effect is on the spirits only. This is by no means the case. The sun is not only a painter but a sculptor." (Nightingale 1860: IX, Light). Florence Nightingale seemed to be inspired by nature in her observations of human beings, somewhat similar to the idea of biomimicry. Biomimicry, also called biomimetics, is the study of the structure and function of biological systems, mostly as models for the design and engineering of materials and machines. Janine Benyus (1997: Introduction) coined the term 'biomimicry' as follows:

"men and women who are exploring nature's masterpieces – photosynthesis, self-assembly, natural selection, self-sustaining ecosystems, eyes and ears and skin and shells, talking neurons, natural medicines, and more – and then copying these designs and manufacturing processes to solve our own problems. I call their quest biomimicry – the conscious emulation of life's genius. Innovation inspired by nature. In a society accustomed to dominating or "improving" nature, this respectful imitation is a radically new approach, a revolution really. Unlike the Industrial Revolution, the Biomimicry Revolution introduces an era based not on what we can extract from nature, but on what we can learn from her."

While the definition refers to a way of copying nature to design *things*, the biomimetic approach is here used as a way of comparing the Danish informants with nature – to show how human beings have ingenious, socio-biological ways of engaging with the environment, designing *lives* according to and with the environment. Like Nightingale, the analogy of a plant is used for describing how nature deals with the sun and the daylight it needs for the photosynthesis and compare this with the behaviour of the Danes participating in the study. A brief summary of how most plants on earth relate to the sun: Plants search for the sunlight, depending on it for their growth. Light-sensitive pigments are sitting at the tip of the leaves or buds, which makes it possible for plants to bend up to 90 degrees towards the light. This kind of growth directed towards the sun is called phototropism and the process is set in motion by a particular growth hormone in the plant called Auxin, derived from 'auxein' which stems from Greek and means 'to grow' (in general, not only plants). For the plants to grow upwards, they have a receptor that responds to the force of gravity (geotropism). The entire system is organized to get and use as much light as possible, but all plants have developed their own strategy. The quest for sun is seen in shapes too; for example, a long tree trunk or plant stem make the tree/plant grow its crown on top where it gets the most sun. Leaves, however, are flat because they get little sunlight. Leaves have their flat side towards the light and sit offset from each other so as not to shade. The capability of growing through the intake of sun thus reflects what is referred to as 'auxination', that trees and plants 'auxinate'. Naturally Auxin only exists in plants, but for the analysis of people's entanglements with daylight 'auxination' is used as a metaphor for the feeling of well-being that people refer to, a representation of a mental growth hormone. Using Auxin metaphorically on humans is both bold and reductionist; none the less, it illustrates the point of people craving daylight from the sun on an existential level.

Despite the research showing that people may crave daylight existentially and sense it bodily, people none the less *react* on daylight, often in material ways; Curtains are drawn; chairs are moved around or they themselves move around and change seats; computers and TV screens are placed where glare is avoided, etc. This is why the data gathering method of the study was chosen to be a qualitative investigation of daylight practices of people to identify qualities of a window: What do people do with window? How do use it with respect to the daylight? How do they talk about daylight, when do they enjoy it particularly (and the opposite), and why? The fieldwork was performed on Zealand and participants were house or flat owners, selected so as to get as diverse a group as possible in terms of age, gender, family status (living alone, with children, and/or husband/wife), life phase (young or old children), living in the countryside and in cities, and having different educations/jobs. A total of 22 people were qualitatively interviewed, using a semi-structured interview guide. Visual ethnography (photos) was used to document actions and postcards was used for storytelling (a retrospect story of a particular situation with a window). After the fieldwork, data was analyzed by using inductive coding, inspired by grounded theory (Denzin & Lincoln 2010). 6 key themes were identified: Daylight and types of daylight; Following the sun and the seasons; View onto the world and into the home resp.; Staging the window: The sill, curtains and decorations; Taking part in life: The role of the window in social life; Safety and functionality. The first two topics refer to daylight and are used for this paper. That daylight affects the materiality surrounding people shows that the entanglement between humans and daylight is often mediated through materiality and on an everyday basis, will be illustrated below.

4 FINDINGS

The general sensory qualities of daylight and its ability to provide well-being to people is the first part of this section, followed by 'healthy daylight', 'types of daylight' illustrating different types of light and how they interact with the materials in the environment the third part, and 'following the sun', showing how daylight appears to resonate with people, prompting them to pursue and interact with daylight. Naturally these parts are intertwined and consequently some overlapping may occur.

4.1. Sensory qualities of daylight

"Umm, just imagine yourself in a spot of sunshine. One should have been a cat."

(Sofie, with eyes closed and a smile on her face)

All informants spoke of daylight as something they were aware of, many referring to it as *"so rare that we simply have to pay it attention"*. Naturally people also referred to feeling annoyed by the light, when there was a glare or it was too sunny, but in general daylight had positive connotations, whereas the negative characteristics, like the fear of skin cancer, related to the sun. Daylight was described as *"essential"*, providing them with *"life and energy"*, feelings of *"happiness"*, *"joy of life, you feel uplifted from sitting inside in a sunny place"*, *"health and cleanliness"*, and as *"a source of inspiration"*. Both the health concern and their emotional and reflective ways of talking about daylight seem to support my claim to see daylight as a bio-social phenomenon integrated in people's lives and reflecting a sense important for their well-being. With such attributes it can hardly surprise that people take great care to get as much daylight as possible into the home, like Sofie, who lives with her family in a house in the countryside, describes in the following quote:

"We have the light and the air, we really have the pleasure of the big sky, and that's wonderful. It's really something we enjoy, so we only have curtains to avoid a glare and in the windows facing the road. And here in the kitchen we changed the door to a glass door so we get more daylight than before. We also try and minimize all the odd stuff in the windowsills, because they steal the light too. It's about getting the heat from the sun and keeping the direct sunlight out." (Sofie)

Maximizing the amount of light that enters the home seems imperative to Sofie (as to the rest of the informants). This may relate to the fact that the sun itself and the daylight it mediates can be sources of inspiration and comfort to the residents. Helena lives in a town in the countryside where she works as a reverend in a parish, and she explains:

"I really enjoy that I have the morning sun and in the afternoon too here at my home office. It's important that I have a lot of windows because I often get inspiration from nature. Daylight provides me with a special calmness and joy, and I often use light in my sermons. The church is designed with a special attention to the incoming light. I find it SO interesting that relatives have told me after burying someone they loved that even in their grief, they felt joy from being touched by the warm sunbeams in the church. The sun comforts and warms us. There's consolation in daylight, a blessing, it's a travel away from darkness. It's also mostly sunny places the children choose to play." (Helena)

The above quotes introduce to the empirical analysis by referring to important characteristics of the sun and its daylight; that these sensations have social features attached, facilitating inspiration and comfort, even the ability to console or empower people in their mourning. However, people not only spoke of the mental contributions of having daylight in their lives and at home, but also functional features that daylight seemed to affect or enable, such as providing the home with light *"more pleasant to see by than artificial lighting"*, and giving character to the shape of the room and its colours. Daylight shapes the room because it provides the room with shadows and spreads out different types of light in the home (Bille and Sørensen 2007).

4.2. Healthy daylight

"It feels healthier with all this brightness, ease and clarity" (Cecilie)

Cecilie and her husband live in an apartment in Copenhagen, at the top floor, with a wide view and daylight pouring through the apartment. She explains that this was a major reason for buying the flat and that the light makes it more pleasant to be home:

"I have a favourite window and that's partly because of the light. Also the frame of the window; that the light is parted exactly the way it is, exactly here. It makes it nicer to be here. It's something to do

with atmosphere. [...] We have little need for lamps now, and it feels healthier with all this lightness, ease and clarity” (Cecilie)

The health issue appears many times in the empirical data, often recounted as a shortage of daylight. Many informants refer to sun and daylight as something they feel they lack. This may be real: Seasonal Affective Disorder is caused by too little daylight resulting in a low production of serotonin. Depending on latitude, the amount of people suffering from seasonal affective disorder (SAD), or from a milder form called sub-syndrome SAD (S-SAD) (Avery et al. 2001a, 2001b) is estimated to be around 5-8% of the population in Denmark, with as many as 10-15% suffering from S-SAD. Young adults and women seem particularly affected by SAD (Roeklein & Rohan 2005). The numbers may be higher, since a more or less vague sense of feeling “blue” or being tired during the entire winter may be information that never reaches the doctor.

Henrik and Mette live in a detached house with their two children in a small town. They have made several changes in their home and also an extension of the house. Henrik took great care in designing a large window that now provides daylight in the living room, the kitchen and the extension throughout the year. He explains further about his interest in daylight:

“I generally pay quite a lot of attention to daylight. Right now it’s a real big issue at work, because management have made the windows dark, it’s like a film they’ve put on all the windows so we won’t get distracted or to avoid a glare or that it gets too hot for us. But I’m in the IT department and look into screens the entire day, so for me it’s really important to have a view and some natural light. Some weeks ago I could enjoy the fields and the light, but now it’s all dark. I’m actually wondering if it will make us depressed. All of a sudden I’ve got a really lousy working environment.” (Henrik)

Henrik refers to the significance of having daylight not just at home but at work too, showing that special functions may have special demands, physically and mentally, for daylight. Being aware of the significance of the sun and daylight for one’s health may partly explain why 70% of the Danes in a population survey made in 2008 by a chain of real estate agents refer to light and influx in rooms as ‘the most important factor for your perception of the living room in a house’ (HOME 2008). Helle, who bought a ground floor of a house in Copenhagen, seems to confirm this finding, *“We get all this light in. It puts you in a good mood. It was one of the reasons for buying the house.”* (Helle) – but light is not a generic category, as will be illustrated below.

4.3. Types of daylight

“The light must in, but it’s ok, nice, if it’s filtered through something, I think.” (Peder)

Jørgen, whose preferred light is “scattered light”, lives in a house from the 40ies and, like Peder, he enjoys light that passes through something, like when light shines through the crown of a tree. This is what Jørgen calls “scattered or filtered light”; to him this type of light is particularly pleasant, as opposed to the sharp, direct light that he and all the other informants find unpleasant to the eye, *“too intrusive”*.

Helle and her family bought the ground floor of a house in Copenhagen, and the old, coloured windows was one of the reasons. Helle enjoys not having the direct sun into their rooms:

“It’s beautiful with the coloured glass and the old windows, but they also require a lot of maintenance. Luckily we don’t get the direct sun here.” (Helle)

So the light from the sun does not fit into one category, ‘natural light’, and negative connotations may appear also. Different types of daylight seem to exist, showing the diversity of the natural phenomena and of the sensory perceptions of people as well. Among light experts daylight is categorized into three groups: Sunlight, skylight and reflex light, but ordinary people are not aware of these categories and distinctions. They have their own ways of categorizing, and in the interviews people described daylight in words like: *“scattered light”, “filtered light”, “sharp light”, “light that blinds”, “direct light”, “direct sun”, “a glare”, “seasonal light”, “healthy light”, “pleasant light”, and “negative light”*. Mette explains about “negative light” that incoming daylight also reveals when it is time for cleaning and that, sometimes, glazed window glass could be a relief in that sense.

The informants also pointed to the fact that light gets its individual character from interacting with the materiality it meets, such as the windows, the room itself, and the interior and colours here. Jørgen

describes it this way: *“The daylight gets its character in combination with the walls and from the way the light is broken and reflected.”* (Jørgen)

Jørgen and Eva have recently got new windows in their house, resulting in *“a totally new home, with all this new light. We so enjoy the light of the seasons”*. Different types of daylight reflect the seasonal environment: from the strong and intense light during summer, to the misty daylight in autumn, to the scarce daylight during winter, occasionally reflected onto the snow and to the daylight in spring that often gives a certain scattered light into the homes, since the sunlight is filtered through blooming trees. The daylight was thus also appreciated for its ability to provide information on the weather and season. The importance of getting knowledge about the world from the natural elements corresponds to other findings on how people use the fresh air from outside into their homes (Hauge 2013a), but is not the focus here; by taking a biomimetic look at the two phenomena the aim is here to show sun and daylight as imbued with sociality by showing people’s social, mental and physiological entanglements with the sun and daylight.

4.4. Following the sun

“I move with the sun.” (Cecilie)

Countries on high latitudes like Denmark have a scarce amount of sun. It was expected that many informants would speak of the high significance of the daylight (all did) precisely due to its scarcity; but many also spoke of enjoying following the sun. They spoke of this both in the sense of keeping watch with its movement on the sky during the day, for instance to figure out at work if they would be able to have time in the garden while it was still sunny, but also physically following the sun inside the home, seeking places of warmth or cold for pleasure (as described also by Heschong 1979).

Architectural design rules tend to promote that houses be placed on the ground according to the movement of the sun, also often involving the rooms: The bedroom is situated in the chill north-east direction, the kitchen frequently faces east, and living rooms south-west so as to enable influx here from the afternoon and evening sun. However, most of the informants had moved into already built houses or flats where it was not always possible to have the specific rooms in the light-wise most favourable position. Still many referred to moving in a kind of synchronous way together with the sun. Cecilie explains:

“These windows and the grand view have probably given us a more intimate knowledge of the weather and the shifting light. We’ve got a different rhythm now. I move with the sun. It’s fun to see that when my husband returns from work, he and Theo [son] automatically seek the light. There’s more physical play here in this room, all the toys move in here even though there is less space to play on. We follow very different routes, but I think that what we probably have in common is following the sun.” (Cecilie)

Ginette lives in a house by herself in a town in the countryside, and like Cecilie she expresses the pleasure of following the sun. Working long hours and often arriving at home when it is dark has made Ginette particularly fond of her kitchen that has a view of the sunrise. This brief moment of taking part in the beginning of the day and seeing the dawning light is highly appreciated:

“To me it’s really important I have daylight where I actually am. The daylight gives me joy and the window is its transmitter. This house is pretty old, but I have big windows, also here in my kitchen facing east. My breakfast is important to me. I can see the sunrise, you know. It really makes you feel uplifted. I’ve designed my rooms according to the sun; in the afternoon and in the evening the sun is in the living room.” (Ginette)

Tove and John live in a house from 1936 where they have renovated the basement and implemented new windows to increase the influx, creating rooms that ‘follow the sun’ in the sense that the office gets the late afternoon sun. Tove explains:

“We can use the basement much better now, it’s not just a place to sleep, because now we have the light and that means I can use it as an office, it’s bright enough even when I get home from work, so you don’t sit here and get depressed.” (Tove)

Tove also describes how she follows the sun on behalf of her plants placed strategically in her house to get different amounts of sun. In windowsills with little daylight or sun, she has put plastic flowers:

“Well, I really fancy orchids, but they can’t grow in these windows, it’s much too warm and sunny.”

And since I don't want to miss the daylight I have to cheat with the plants." (Tove)

So the daily influx may also set limitations to people (and their plants), but it is not regarded as a problem but rather something that needs to be dealt with creatively.

5 DISCUSSION

Naturally the window plays an important role regarding quality and amount of the solar influx, but despite amount and style of windows informants were in general highly aware and very interested in daylight. This interest in daylight may not only be biologically or socially based, but also cultural: Having many windows and thus much access to daylight used to signify a high social class, status and wealth since glass used to be extremely expensive (Hauge 2013a).

Informants also seemed to mix the physical and physics based nature of daylight with the social. This was to be expected since people have little knowledge of the physics behind daylight. One example is the fact that in nature light creates color: Color is defined by the amount of light that an object reflects over a range of wavelengths in the visible light spectrum. Colorful appearances depend on the surface reflecting light rays differently, thus changing the overall synthesis of perception. People might not know the scientific explanation, but in fact they appeared to try and use walls/surfaces strategically for making use of the incoming daylight.

Separating the positive significance of daylight from other sensations is difficult also because of the intertwinement of sensations. For instance, more access to daylight is only one element in the increased dopamine production that appears during spring. Dopamine may also be triggered by the general increase in novel information to the brain. These pieces of novel information involve many sensations, such as new and more colors, new smells, seeing more of people's physical bodies, all making people more susceptible to falling in love (Fischer 2006). Knowing such explanations, however, seem irrelevant for people in their everyday life where they simply react on a physically felt sensation: That the daylight may make a glare, it may become too warm, or they may feel the need for sunglasses. None the less, they all referred to daylight using positive words by far. Many informants referred to the pleasure of sitting in a spot of sun, finding a sunny corner, lifting their heads to the sun. Like plants, the Danes participating in the study appeared to follow the sun for auxination. For plants, to grow upwards their entire system is organized to use light as much as possible, but all plants have their own strategy. This we see among the Danes too: Indulging in sun bathing is of course an individual matter, also due to the skin being more or less fragile, shy, heat tolerant, etc. Still, despite differences in how much sun people liked, all the Danish participants in the study expressed a need for daylight in order to stay healthy and avoid SAD. Some had invested in new windows to get more light, others preferred windows without curtains to allow for as much light as possible. All were remarkably attentive to sun and daylight, referring to it as a source of energy and inspiration. All analytical parts thus seem to support the idea of daylight representing a sense among people, anchoring them in the world not merely as perceived sensations that remain within their bodies and minds, but by daily considerations and actions that precisely relate to the sun and its daylight. So daylight as an element for creating a sense of dwelling at home may have been substantiated above (the sensory qualities are known and used by architects already, like Descottes & Ramos 2011, Plummer 2012), but the question now remains as to how such *social and existential* findings may be of use when designing and building a residence. Some suggestions will be given in the conclusion as biophilic building designs.

6 CONCLUSION

Taking into consideration that humans in modern cities spend up to 90% of their time indoors (EPA 2014), occupying statically, perhaps stagnantly, lit environments, they are at risk of becoming disassociated with the natural outdoor cycles and variation of luminance levels if daylighting is compromised in building designs. To the Danes, the sun and its daylight appeared important in their lives in the sense that these natural phenomena had an impact on the design of their lives and their well-being at home. The biomimetic inspiration enabled the comparison between plants and humans who both turn to the sun and engage in a symbiotic relation with the sun and the daylight. Like plants (some) human beings auxinate. Taking a new approach like this may be useful to understand the complex nature of daylight as something sensuous to the individual and with bio-social qualities. We perceive life by sensing it (for instance through auxination), we enact life by reacting on the sensations as life goes on, and we design life that allows for dwelling by using our homes as sites of sensing the

world. People respond to their environment and different seasons, thermal zones and climates, and incorporate the dynamic environment and its seasons. When lives are lived in accordance with the natural environment human beings often live seasonal lives with a distinct social morphology for each (Mauss 1979). The type and frequency of seasons in Denmark also seem to prompt a kind of organization of people's lives, including paying special attention towards the sun and daylight, and in the sense that people basically need to adjust to the seasons and their individual characteristics. There is a saying in Denmark, probably common to many countries, 'the weather is never lousy, but your clothing may be', reflecting the need to dress to the occasion: The weather. Also that fact that all the Danish informants state that sensing the sun and daylight in their lives is highly cherished and something that makes them feel well is a further argument for acknowledging access to daylight at home as vital to people. Together this makes *daylight a natural starting point for designing buildings*, something that resonates particularly well with *biophilia and biophilic buildings*. 'Biophilia' was coined in 1984 by biologist Edward Wilson, who argued that human beings have an innate evolutionarily based affinity for nature and that we seek to connect with nature. The concept of biophilia can inform building design and many examples of green design incorporate aspects of biophilic design (still, many, unfortunately, do not). The results from the Danish investigation are an argument for this incorporation. Biophilic building design principles is about acknowledging the affinity for nature and will often involve increased glazing areas. This may, however, come with a penalty of increased energy consumption, so designing with this particular biophilic feature may make it more difficult to achieve energy conservation goals. Other strategies, such as large glazing areas of high-visible-transmittance glass, operable windows, and indoor-outdoor spaces that connect people with nature, may carry even more significant energy penalties. These conflicts are real, but surmountable, a.o. due to new low-emissivity glazing that allows visible light to enter buildings while reducing unwanted heat gain and heat loss. Designers may need to work a little harder to maximize energy efficiency elsewhere in the building to compensate for some energy penalties with biophilic designs, and building owners or developers may have to invest more in ecological restoration and landscaping to turn urban brownfield sites into beautiful biophilic assets, but this is doable. Biophilic design involves understanding potential conflicts and achieving the right balance. Critical next steps for an improvement of biophilic building design would involve a better diffusion of daylight throughout the home, allowing for filtered light and making use of transparent building elements within the home. Together with knowledge gained from an elemental anthropology (studying the air, rain, sun, earth, thermal environments in people's lives) it may be possible to highlight the intertwinement of these natural elements and people, as was the aim of this article: To show people's sensations *in the living*, their relations to daylight and their practical engagements with the sun and the daylight in their day-to-day living. In other words, experiencing the world through sun and daylight integrated in people's bodies and lives. The 'new under the sun' is that by doing so *sun and daylight become imbued with sociality*. The sensation of daylight normally taken for granted and seen as a physiological element in our everyday life has been foregrounded and shown as a sense in people, one that may have a physiological origin when daylight hits the eye, but whose 'effect' on people and their lives may best be investigated psychologically and socially, when studying how the daylight sensation is practiced by people and how the sensation entangles and intertwines with people's everyday lives. This way a more profound understanding of the significance of natural phenomenon to people may appear – a knowledge that may inspire building designers to prioritize elements that favour human sensation and (controlled) interaction with the elements.

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ⁱ It may not be views of nature, per se, that elicit the positive responses to biophilic design, but something about those views, or images: Mathematically defined *fractal patterns*. Fractals are complex geometric shapes that appear to repeat at finer scales; such shapes are often found in nature and can be defined mathematically. Psychologist James Wise believes the beneficial psychological effects of fractals have the same evolutionary basis as other aspects of biophilia but that these benefits can be achieved by fractals alone, obviating the need for

actual images of nature. The implication is that we should incorporate fractal-patterned fabrics, wall coverings, and artwork as well as fractal patterns from nature (such as clouds, ocean waves, tree branches, or ferns) into our buildings (Environmental Building News, July 2006, 15:7: www.buildinggreen.com, downloaded 7th December, 2014).

ⁱⁱ For thousands of years people all over the world have revered the importance of light for the functioning of the human body, using sunlight for medical treatments. The first records indicate that heliotherapy dates from about 1400 BC. Hindus treated patients with skin disorders using different plants followed by exposure to sunlight. Hippocrates, in the IV century BC, recommended sunlight to treat a variety of diseases. At the end of the 19th century, heliotherapy was recognised by many physicians. “Open-air” exposure to natural sunlight was widely used for the treatment of wounds during both the First and the Second World War in the United Kingdom, Italy, France and Germany (Biopton 2007). Daylight for medical purposes prompted sun bathing as a practice in the North Western part of Europe.

ⁱⁱⁱ Definitions for daylight sufficiency originate from the early twentieth century British law and the principal of ‘Right to Light’ under the Prescription Act of 1832 which ensures the owner of a building with windows that have received daylight for 20 years or more the right to prevent the construction of a building or obstruction that would interfere and deprive the existing building with said daylight illumination. The DF measurement technique evolved over time and recommended threshold values vary drastically, from 0.1 to 10 DF (0.001–0.10 of outdoor illumination) depending on occupancy type and regional lighting expectations. Although easy to measure, conceptually clear, and considered point-by-point or as an average by space, and generally consistent over time regardless of the amount of illumination outdoors, it is limited in use to overcast sky conditions and does not give adequate information about visual comfort in a space, and no longer considered a viable metric in abundantly sunny climates (van den Wymelentberg 2008).

