

The Impact of Daylight in Workspaces on Productivity

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Daylight plays an important role in human life. Light controls our circadian rhythm, the 24-hour cycle also known as the internal body clock. The 2017 Nobel Prize for medicine was awarded to researchers who discovered the underlying mechanisms of maintaining circadian activity in every cell.

Generally speaking, daylight suppresses the secretion of the hormone melatonin, which induces sleep, hence light governs wakefulness. In addition, the ultraviolet wavelengths in daylight affect the production and synthesis of vitamin D and positively affect the immune system.

Disruptions to the sleep-wake cycle (for instance through jet lag, or shift work) have recently been shown to disorder the circadian cycles of hundreds of genes that normally maintain, repair and protect the human body.¹

Therefore, daylight is generally known to impact wellbeing. But how does it matter in workplaces?

What do we mean by 'daylight'?

Daylight, or levels of illumination from natural light can range from 1000-2000 lux on an overcast day at midday up to 100,000 lux in bright sunlight.²

In workspaces, daylight can mean different things and be measured in many different ways, for instance the average amount of lux achieved within a given space and building configuration per year; the ratio of the area of windows or skylights to the floor area being lit; the daylight factor, which measures the percentage of lux in the centre of a room compared to the illuminance levels outdoors; the minimum distance from a workstation to the closest source of daylight; but daylight can also include glare or thermal gain; it may mean prospect, or what can be viewed of the outside world through windows; or it can be interpreted as a matter of control of a working environment, for instance by being able to pull down blinds.

In the context of this report, we will focus on the difference daylight makes at work (as opposed to working in windowless environments) and also touch upon the impact of prospect.

¹ Archer, Simon N., et al. (2014), 'Mistimed sleep disrupts circadian regulation of the human transcriptome', *Proceedings of the National Academy of Sciences*, 111 (6), E682-E91.

² Source: <https://en.wikipedia.org/wiki/Daylight>

Daylight regulations – International overview

Many countries around the world have understood the importance of daylight for human wellbeing and have put legislation in place to safeguard access to daylight.

In several countries no minimum legal requirement regarding daylight exists, among them *Switzerland, Ireland, UK, USA* and *South Africa*.³

Most notably in the USA, many examples of workplace designs are known which do not consider daylight as important. Workspaces without any direct access to daylight are commonly found.

In the European Union, the EU Workplace Health, Safety and Welfare Regulations of 1992 demand that “every workplace *shall* have suitable and sufficient lighting” and that this lighting “*shall*, as far as is reasonably practicable, be by natural light”. The regulations do not define what counts as sufficient and do not distinguish between natural light and artificial light.⁴

Several countries go further in protecting regular access to natural daylight for their citizens.

Sweden for instance requires that “rooms or separable parts of rooms in buildings in frequent use by human beings shall be designed and oriented so that adequate access to direct daylight is possible”. The regulations recommend that the area of window glazing amounts to 10% of the floor area that is being lit.⁵

In *Germany*, regulations were tightened in 2016 and now stipulate that only spaces with sufficient daylight and an external view are permissible as workspaces (with few exceptions).⁶ A daylight factor of 3% is recommended for workspaces, i.e. the amount of daylight measured in the centre of a room must be at least 3% of the illumination measured outside at the same time of the day.⁷ This has an impact on workplace layouts, since very deep floor plates will not achieve the required levels of daylighting.

This overview highlights that the priority the UK puts on the provision of natural daylight through legislation or regulation, is low compared with several other countries around the world.

³ Source: https://www.designingbuildings.co.uk/wiki/The_daylight_factor

⁴ Source: <http://www.hse.gov.uk/pUbns/priced/l24.pdf>

⁵ Source: http://www.fuktcentrum.lth.se/fileadmin/fuktcentrum/PDF-filer/6_Hygiene_health_and_the_environment.pdf

⁶ Source: http://www.fvlr.de/tag_gesetzeslage.htm

⁷ Source: <http://publikationen.dguv.de/dguv/pdf/10002/i-7007.pdf>

Why and how does daylight matter in the workplace?

Daylight affects human wellbeing and governs the ordinary functioning of human physiology. Architecture and the structure of the built environment can have a strong impact on human wellbeing.

“We define quality in architecture as that which elicits human wellbeing.”⁸

Ben Derbyshire, President of the Royal Institute of British Architects (RIBA), 16th December 2017

Office workers spend the majority of their waking hours inside their workplace, hence getting access to daylight while in the office can have major repercussions for wellbeing.

But what is the exact impact of natural daylight and prospect that scientifically rigorous evidence can provide?

Performance gains through natural daylight

Firstly, research studies suggest that there is a connection between access to daylight and increased employee satisfaction. If asked, humans consistently express explicit preference for natural daylight in offices and cite psychological comfort, health and aesthetics as main reasons.⁹

It is also argued that daylight has an impact on productivity, since happy and satisfied employees are also more productive at work.¹⁰

Several case studies from the US underline this point. A study of Lockheed Martin moving into their new intensively daylighted office headquarters for 3,000 staff in Sunnyvale, California reported large increases in productivity based on reducing absenteeism by 15%.¹¹ A similar case is described for furniture manufacturer Herman Miller moving into their new headquarters in Zeeland, Michigan. After nine months of working in their new building, called the ‘Green House’ for its ample use of courtyards, internal gardens and skylights, staff productivity had risen by 20%.¹²

Productivity at work is often difficult to measure. Therefore, looking into comparable settings with readily defined productivity metrics can be insightful. Schools provide a good case in point, since children go there every day for extended periods of time, while

⁸ RIBA President Ben Derbyshire on Twitter, see:

https://twitter.com/ben_derbyshire/status/942099056070922241

⁹ Heerwagen, Judith H. and Heerwagen, D. R. (1986), 'Lighting and Psychological Comfort', *Lighting Design and Application*, 16 (4), 47-51.

¹⁰ Haynes, Barry (2008), 'The impact of office comfort on productivity', *Journal of Facilities Management*, 6 (1), 37-51.

¹¹ Thayer, Burke Miller (1995), 'Daylighting and Productivity at Lockheed', *Solar Today*, 9 (3), 26-29.

¹² Cited in: Goldhagen, Sarah (2017), *Welcome to your world. How the built environment shapes our lives* (New York: Harper Collins).

performance measurements, for instance in the form of attainment figures are reliable and consistent.

Two studies from the US provide interesting insights. Research published in 1997 found that students in a school in California showed a 14% performance increase in standardised CAT scores (California Achievement Test) when moving into a daylight design.¹³ A much broader and comprehensive study from 2002 confirmed these results. It compared more than 100 elementary schools in three US districts (in California, Washington and Colorado) regarding degree of natural daylight and its influence on student performance in standardised tests. Schools with best daylighting conditions showed a 20-26% faster rate of improvement over a one-year period than classrooms with lowest provision of windows in California; respective results for other two districts were comparable with slightly lower size effects (8-15% in Washington and 14-18% in Colorado).¹⁴

Rigorous evidence on prospect is more difficult to establish, however one study found that undergraduate students with a view of nature from their dormitory window also showed higher attentional performance and reported functioning more effectively in daily life activities than their counterparts without a view.¹⁵

Stress reduction

Research highlights that exposure to daylight can result in reduced levels of stress, although this was established in workplace settings other than offices. For instance, a study of 141 nurses in a hospital found that those exposed to more than 3 hours of daylight per day reported significantly less work-related stress and higher levels of job satisfaction.¹⁶ Similarly, daylight had a positive effect on patients. Post-operative patients with beds allocated on the bright side of a hospital unit were exposed to 46% higher-intensity sunlight on average; they perceived significantly less stress than patients on the dim side of the hospital unit and took 22% less analgesic medication per hour.¹⁷

Exposure to levels of bright light (>1000 lux) were also associated with significant mood improvements. In an experiment, 48 study participants wore a light meter on their wrist for 20 days and recorded in real-time their behaviours, mood, and perceptions of others

¹³ **Nicklas**, Michael H. and **Bailey**, Gary B. (1997), 'Daylighting in Schools: Energy Costs Reduced... Student Performance Improved', *Strategic Planning for Energy and the Environment*, 17 (2), 41-61.

¹⁴ **Heschong**, Lisa, **Wright**, Roger L., and **Okura**, Stacia (2002), 'Daylighting Impacts on Human Performance in School', *Journal of the Illuminating Engineering Society*, 31 (2), 101-14.

¹⁵ **Kaplan**, Stephen (1995), 'The restorative benefits of nature: Toward an integrative framework', *Journal of Environmental Psychology*, 15 (3), 169-82.

¹⁶ **Alimoglu**, Mustafa Kemal and **Donmez**, Levent (2005), 'Daylight exposure and the other predictors of burnout among nurses in a University Hospital', *International Journal of Nursing Studies*, 42 (5), 549-55.

¹⁷ **Walch**, J. M., et al. (2005), 'The effect of sunlight on postoperative analgesic medication use: a prospective study of patients undergoing spinal surgery', *Psychosom Med*, 67 (1), 156-63.

during social interactions. Whenever they were in brighter conditions, participants were more agreeable and enjoyed less quarrelsome social interaction behaviours with others.¹⁸

It can be assumed that these results will be relevant for workplace environments, yet detailed research on this has yet to be undertaken.

Reduction of depression and seasonal affective disorder (SAD)

Seasonal affective disorder is a condition similar to depression that occurs repetitively at the same time of the year, typically in the winter months, when levels of natural light are lower. The relationship between exposure to natural daylight and a reduction in SAD is often assumed, but not fully established by scientific evidence; therefore, the National Institute for Health and Care Excellence (NICE) in the UK does not recommend light therapy to treat SAD.¹⁹ Recent research underlines that the reduction of depression and particularly SAD due to daylight exposure is not fully understood yet. More complex physiological and psychological mechanism may be at play warranting further research.²⁰

Better sleep

Most recent research points to a clear impact of daylight on quality of sleep. In a detailed study of 49 office workers at the University of Illinois at Urbana-Champaign (27 working in windowless offices and 22 working in offices with windows) significant differences were found regarding quality of sleep. On average, workers in workplaces with windows slept 46 minutes longer per night than those without access to natural daylight in their workplace. Workers with direct window access also reported higher scores on the Pittsburgh Sleep Quality Index (PSQI).²¹

Insufficient sleep is associated with a wide range of health-related problems, such as higher levels of cortisol in the evening, impaired glucose metabolism as well as increases in appetite, which is linked to higher body mass index figures. Insufficient sleep quality also leads to increased fatigue, performance deterioration, lack of alertness and problems with concentration.

¹⁸ **Aan het Rot, M., Moskowitz, D. S., and Young, S. N. (2008)**, 'Exposure to bright light is associated with positive social interaction and good mood over short time periods: A naturalistic study in mildly seasonal people', *Journal of Psychiatric Research*, 42 (4), 311-19.

¹⁹ Source: <https://www.nhs.uk/conditions/seasonal-affective-disorder-sad/treatment/>

²⁰ **Aries, Myriam BC, Aarts, Mariëlle PJ, and van Hoof, Joost (2015)**, 'Daylight and health: A review of the evidence and consequences for the built environment', *Lighting Research & Technology*, 47 (1), 6-27.

²¹ **Boubekri, Mohamed, et al. (2014)**, 'Impact of Windows and Daylight Exposure on Overall Health and Sleep Quality of Office Workers: A Case-Control Pilot Study', *Journal of Clinical Sleep Medicine JCSM: Official Publication of the American Academy of Sleep Medicine*, 10 (6), 603-11.

Conclusions

In summary, there is strong scientific evidence that natural daylight has an impact on human wellbeing:

- it eases concentration and learning;
- raises productivity;
- reduces stress;
- and means better and longer sleep at night.

The impact of views to the outside world enabled by windows, also called prospect, is less well researched as a factor contributing to productivity at work. However, scholarly work has provided initial evidence, which suggests that prospect and views of nature increase attention. More research is needed to substantiate these findings in the context of workplace design.