

DAYLIGHT PERFORMANCE Research Brief

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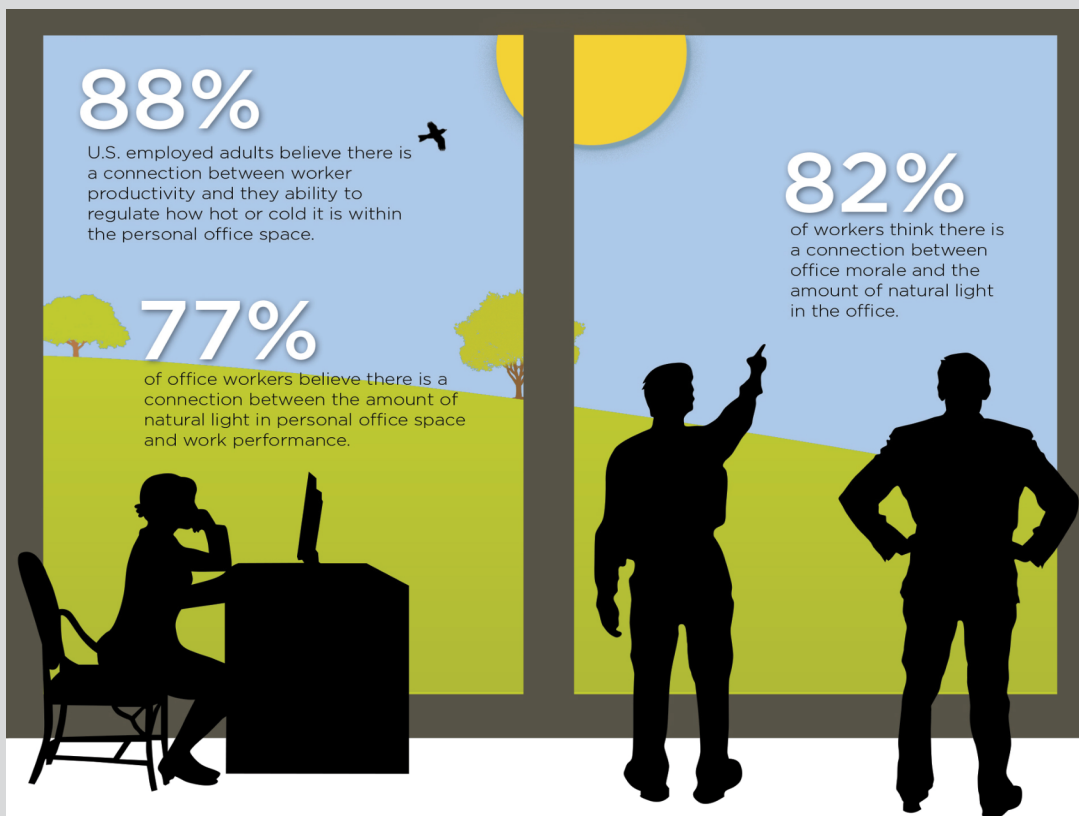


Figure 1:

A majority of office workers believe that exposure to daylight positively impacts their performance at work.

Source: <https://www.businesswire.com/news/home/20130910006112/en/New-Office-Perk-Daylight>

Keywords:

daylight, performance, productivity, financial performance, academic performance, cognitive performance, absenteeism, alertness

CONTENT OVERVIEW

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DAYLIGHT + PERFORMANCE SUMMARY

In addition to supporting physical and mental health, which both indirectly support increase performance and productivity, daylight positively impacts performance in other ways as well. Increased alertness, better color rendering, less flicker, reduced absenteeism, increased financial performance and increased academic performance have all been seen with increased access to daylight.

I. Improved Employee Performance

Increase exposure to daylight has positive impacts on worker performance through a number of factors. By improving and supporting the health and well-being of employees, daylight indirectly supports performance (Edwards 2002 38) because daylight, and circadian rhythms in particular, “affect the ‘platform’ from which we operate and consequently affect all parts of the brain and body” (Edwards 2002 33). Boyce notes that “the performance of both visual and non-visual tasks will be affected by disruption of the human circadian system. A disrupted circadian system will also create long-term health problems. Exposure to bright light during the day and little or no light at night will accurately entrain the circadian system. Daylighting is an attractive way to deliver bright light during the day.” (Boyce 2003 65). Increased alertness is also a contributing factor to increased performance; daylight and the body’s associated melatonin reduction after exposure to daylight have “an alerting influence on the central nervous system” (Van Bommel 2006 261) and create “an immediate alerting effect that leads to better task performance” (Boyce 2010 15, Ulrich 2008 90). Furthermore, “natural light increases attention and alertness during the post-lunch dip and has shown to be helpful in increasing alertness for boring or monotonous work” (Edwards 2002 10). Better lighting has been attributed to “improvements in productivity, a decrease in accidents, an increased level of mental performance, [and] improvements in sleep quality” (Edwards 2002 9) and daylight has “a great probability of maximizing visual performance than most forms of electric lighting because it tends to be delivered in large amounts with a spectrum that ensures excellent color rendering” (Boyce 2003 3).

*Physiological
Impacts*

Alertness

Increases in performance and productivity due to improved lighting conditions have been observed in various companies, including Lockheed Martin, Verifone, and the Reno Post Office (Edwards 2002 10). By moving to an open office with integrated daylight, Lockheed Martin was able to increase contract productivity by 15% and believed the increased productivity helped them win a \$1.5 billion defense contract (Edwards 2002 10). At Verifone, daylight helped their distribution center increase productivity by 5% and total product output by 25%-28%, “making the new building more cost effective than first predicted” (Edwards 2002 10). For the Reno Post Office, when combined with better electric lighting, indirect daylight increased the productivity of mail sorters by 6%-8% while decreasing errors to .1% (Edwards 2002 10). Lastly, Story County Human Services, in Iowa, was able to increase the amount of people served and seen. One group tripled the number of people served while another doubled the number of people served (Edwards 2002 12). Increases in performance are an important payback of investments in daylight because “the energy and operating costs of a building are small when compared to the cost of employees and initial construction. For daylighting to pay for itself, the dollar value associated with office worker productivity must increase beyond the added cost of implementing daylighting technology” (Edwards 2002 12). In terms of the financial returns from increased performance, the Reno Post Office saw productivity gains of \$400,000 to \$500,000 per year, paying for the renovations in less than a year while Lockheed Martin saw financial gains from increased productivity while also saving approximately \$500,000 in energy expenses and decreasing absenteeism. (Edwards 2002 12).

Case Studies

*Impacts of
Performance
Improvement*

// Improved Financial Performance

Beyond increasing employee performance, daylight improves the financial performance of spaces as well. Numerous studies have shown that daylight stores have higher sales numbers than non-daylit stores (Edwards 2002 27-8, Boyce 2003 66). Daylight “has aesthetic benefits that encourage customers to enter the store” (Edwards 2002 27) likely contributing to the fact that the Heschong Mahone Group found adding skylights increased store sales by 31%-41%” (Edwards 2002 28). The presence of skylights was found to be statistically significant to increased retail sales, ranking third in influence behind operating hours and years since the last store retrofit (Boyce 2003 60). In addition to encouraging sales, daylight improves color rendering and color discrimination, allowing employees to more quickly located stock from the storeroom and to make signage easier to read, preserving the value invested in the graphic design of the signage (Edwards 2002 30).

An unnamed store found an 28% increase in sales compared to other, non-daylit stores (Edwards 2002 17), while Walmart saw “increases in sales, employee perspective, and shopping habits...in a section of the store with skylights compared to a section without” (Edwards 2002 28). Furthermore, “retail sales in the daylight area of the store [were] higher than the area without skylights, and [higher than] other Walmart stores in the area . . . The sales pressure [sales per square foot] was significantly higher for those departments located in the daylight half of the store” (Edwards 2002 28). Lamb’s Thriftway, a grocery store in Portland, OR, found that skylights in the produce department led to very low employee turnover, increases in employee happiness, and increased sales in the produce department. “The produce department sales more than doubled while the rest of the store did not quite double” (Edwards 2002 30). Though they have kept their numbers confidential, Target has increased the number of stores using daylight, which proved helpful in the rolling blackouts during the California energy crisis. Daylight helped one store reach “the highest level of appreciation” in guest services surveys due to brightness and cleanliness, both attributed in part to the natural light (Edwards 2002 29). For industrial uses, early studies on the productivity impacts of light on building occupants looked at industrial workers such as silk weavers, linen weavers, and manual type-setters, showing “a clear relationship between work output and the amount of daylight available” (Edwards 2002 36). Additionally, the benefits of improved worker health decrease the cost of the products being produced because of a reduction in lost time due to health issues (Edwards 2002 36).

Educational and medical buildings can also reap financial benefits from utilizing daylight. Schools in particular benefit from decreased energy bills and enhanced learning environments (Edwards 2002 24). On a per student basis, reduced absenteeism saves the cost of providing for students who aren’t present (Edwards 2002 24). In other words, money spent on the learning environments through operational, material, and staffing costs is wasted when students aren’t present, so by ensuring more students are present, daylight helps funding be more efficiently used. Healthcare facilities also benefit from reduced operating costs and energy bills but also because “patients recover faster in daylight recovery centers” (Edwards 2002 33). Patients in sunny rooms had “marginally less pain, took 22% less analgesic medication per hour, and had 21% less pain medication costs,” helping reduce overall facility operating costs (Joseph 2006 6). Additionally, myocardial infarction patients experienced shorter stays when assigned to sunny rooms compared to rooms in shade, particularly for women patients. Mortality rates were lower in the sunnier rooms as well. (Ulrich 2008 91) Overall, daylight post-surgical facilities improve the mental well-being of patients, and by “improving the mental well-being of patients improves their recovery rates” (Edwards 2002 34). By increasing decreasing the amount of pain medicine used and the length of recovery time, healthcare facilities are able to treat more patients within the same time frame, increasing their efficiency. For more information see the Daylight + Physiological Health Research Brief.

III. Improved Academic + Cognitive Performance

Daylight has been shown to contribute to higher cognitive performance and increased test scores for children. Studies have shown that “students in daylit schools had higher reading and math achievement scores” (Edwards 2002 19) and that “children in classrooms with the best daylighting...showed higher end-of-year test scores than children in classrooms with no daylight” (Boyce 2003 61). In one study of schools in North Carolina, two schools in the same district had increased test scores of 7% and 18% compared to an 5% increase in a newly built schools that didn’t incorporate daylight and a 5% average increase across the district (Edwards 2002 20). For a closer look at the impact on specific test scores, see Edwards 2002 19-22. Additionally, “students have shown better behavior in properly [day]lit libraries than traditional fluorescent-lit schools” (Edwards 2002 21). While there is difficulty in saying precisely why daylight has positive impacts on students, possible causes include “better distribution of light, improved visibility from improved light, better color rendering, and the absence of flickering from electrical lighting” (Edwards 2002 22). It is worth noting that while the “positive effect of daylighting was distinct from all other attributes from windows,” (Edwards 2002 22, Hescong 1999), “it is not [just] daylight per se that enhances education, but the way that it is delivered,” due to potential for visual and thermal discomfort (Boyce 2003 62).

Edwards notes that “a school with insufficient light can also reduce a student’s ability to learn due to the effect lighting has on physiology. Poor spectral light can create strain on students’ eyes, leading to a decrease in information processing and learning ability, causing higher stress levels” (Edwards 2002 18). Higher stress levels can the impact certain growth hormones, and the “increased activity of these hormones supports researchers’ observations that children under electric lights all day have decreased mental capabilities, agitated physical behavior, and fatigue” (Edwards 2002 18, Daylight+Stress).

IV. Reduced Absenteeism

Daylight also impacts performance by reducing absenteeism through supporting building occupant’s health and well-being. Numerous studies have shown improvements to daylighting in office spaces to reduce absenteeism. Lockheed Martin saw a 15% decrease in absenteeism after moving to new daylit offices while Verifone saw an absenteeism reduction of 6.8 hours per person per year, improving attendance rates by 47% (Edwards 2002 11). Even changes to internal organizational layouts can have impacts on absenteeism; by limiting desks to within 23 feet of windows, the International Netherlands Group Bank saw at 15% decrease in absenteeism, “a dramatic growth in business,” and the creation of “a progressive, creative bank image” (Edwards 2002 11).

Reductions in absenteeism have also been shown in schools. Schools with integrated daylight “show an increase in student and teacher attendance when compared to traditionally lit schools” (Edwards 2002 19). Furthermore, this reduction was found to save a school district about \$203 per student per year between 1981 and 1985 based on the required expenditures for students (i.e. the wasted cost of providing for students who weren’t there) (Edwards 2002 24).

Daylight impacts the absenteeism with industrial uses as well. Windowless factories saw more absenteeism problems and increased vandalism compared to factories with windows, so providing more access to daylight would be anticipated to help alleviate some of these issues (Edwards 2002 36).

V. Decreased Performance

However, more daylight does not always simply translate to better performance; it can decrease performance if improperly or poorly considered. As Boyce notes, “daylight can cause visual discomfort through glare and distraction, and it can diminish the stimuli the task presents to the visual system by producing veiling reflections or by shadows. The effectiveness of daylight for visual performance will depend on how it is delivered. The same applies to electric lighting” (Boyce 2003 65). Furthermore, the “speed and accuracy of performance [will] deteriorate with reduced visibility in a non-linear manner...luminance contrast is a major determinant of task performance” too (Boyce 2003 13). Edwards also notes that “improper use of daylighting can reduce productivity and increase employee absenteeism due to the possibility of extremely high lighting levels, excessive glare, and high temperatures” (Edwards 2002 16). Additionally, performance is decreased through the tactics employees use to cope with the problems of improper lighting because they “distract employees from their work and were not effective... with these ineffective coping methods, dissatisfaction, loss of work efficiency, reduced motivation, and fatigue were possible results. If employees tried to ignore the problem, mental energy would be absorbed that could have been focused on their work” (Edwards 2002 16).

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- ["Your Office's Fluorescent Lights Really Are Draining Your Will to Work"](#) - Fast Company