DAYLIGHT PERFORMANCE
Talking Points

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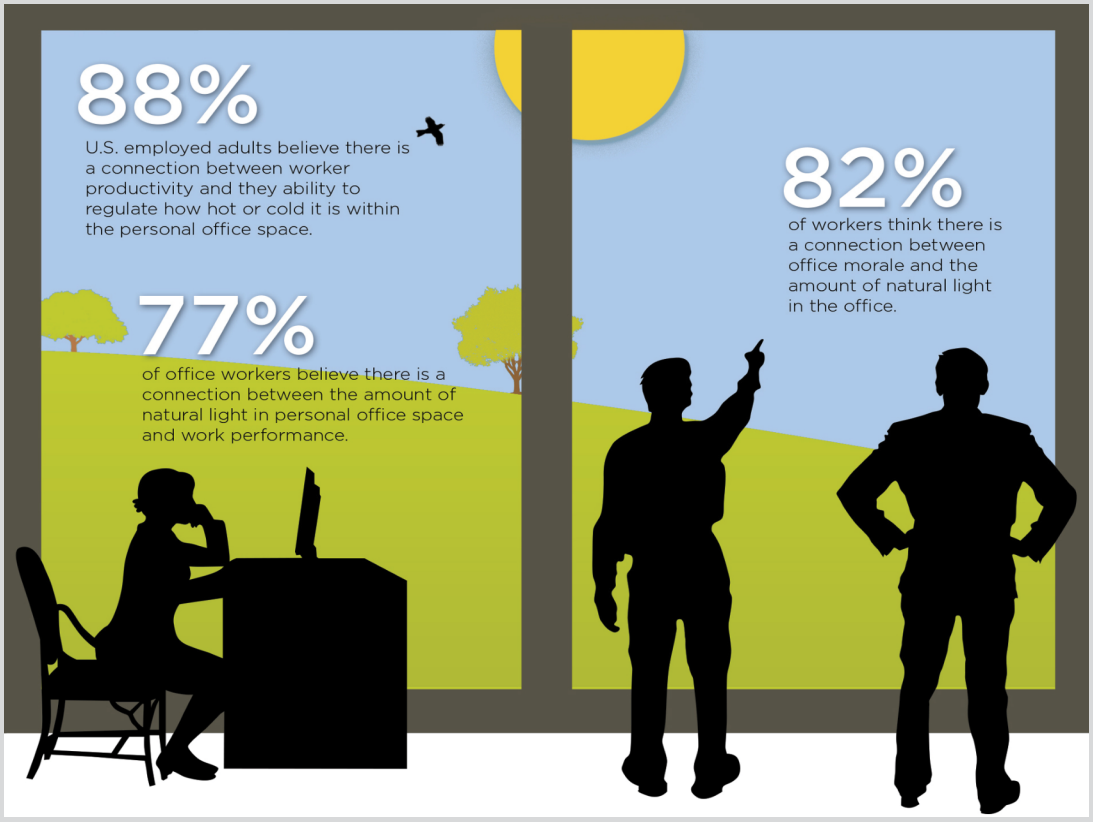

Figure 1:
A majority of office workers believe that exposure to daylight positively impacts their performance at work.

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

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.

DAYLIGHT PERFORMANCE Talking Points

I. Improved Employee Performance

i. Physiological Impacts

a. By improving and supporting physiological health and well-being, daylight impacts performance by influencing the "platform" from which productivity originates.

b. Both visual and non-visual tasks will by affected by disruption of the circadian system, particularly because this disruption has long-term health consequences,

ii. Alertness

a. Daylight and the associated suppression of melatonin have an alerting influence on the body

b. Increased alertness increases employee performance

c. "Natural light increases attention and alertness during the post-lunch dip and has been shown to be helpful in increasing alertness for boring or monotonous work." (Edwards 2002)

d. 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)

e. Daylight tends to be better at maximizing visual performance than most electric lights because of both the quantity and spectral quality of light delivered.

1. This is particularly useful for maximizing color rendering.

iii. Case Studies

a. Increased performance from daylight has been observed with a variety of companies.

b. Lockheed Martin increased productivity by 15%, leading to them winning a $1.5 billion defense contract.

c. A Verifone distribution center increased productivity by 5% and total product output by 25-28%.

1. Performance increases made the new building more cost effective than first predicted.

d. The Reno Post office increased the performance of mail sorters by 6-8% and decreased errors to .1% by better integrating electric light with daylight.

e. In Iowa, Story County Human Services was able to increase the amount of people served and seen.

1. One group tripled the number of people served while another doubled the number of people served

Improved Employee Performance cont.

iv. Impacts of Performance Improvement

a. Increases in performance are an important payback of investments in daylight because the costs of employee salaries and initial construction are much larger than building energy and operating costs.

b. "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).

c. 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.

d. Lockheed Martin saw financial gains from increased productivity while also saving approximately $500,000 in energy expenses and decreasing absenteeism.

II. Improved Financial Performance

i. Increased Sales

a. Numerous studies have shown that daylit stores have higher sales numbers than non-daylit stores.

b. Daylight encourages customers to enter stores.

c. Added skylights were found to increase store sales by 31-41%

d. Presence of skylights was found to be a statistically significant factor to increased retail sales, ranking third behind operating hours and years since last retrofit.

e. Daylight improves color rendering and color discrimination

1. Employers are able to more quickly locate stock.
2. Signage is easier to read, preserving the value invested in graphic design of signage.

ii. Case Studies

a. An unnamed store found an 28% increase in sales compared to other, non-daylit stores

b. 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).

1. Furthermore, "retail sales in the daylit area of the store [were] higher than the area without skylights, and [higher than] other Walmart stores in the area" (Edwards 2002)
2. "The sales pressure [sales per square foot] was significantly higher for those departments located in the daylit half of the store" (Edwards 2002).

Improved Financial Performance cont.

c. 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.
    1. "The produce department sales more than doubled while the rest of the store did not quite double" (Edwards 2002).

d. 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.
    1. 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.

e. For industrial uses, early studies demonstrated a direct relationship between daylight and worker output.
    1. Improved worker health due to improved daylight access decrease the cost of production due to lost time from health issues.

iii. Healthcare + Education

a. Schools in benefit from enhanced learning environments.

b. On a per student basis, reduced absenteeism saves the cost of providing for students who aren't present.
    1. 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.

c. Healthcare facilities benefit from reduced operating costs due to faster recovery times due to increased daylight exposure.
    1. Heart attack patients had shorter hospital stays when assigned to sunnier rooms, particularly for women patients.
    2. Mortality rates were lower in sunnier rooms as well.
    3. For more information, see Daylight+Physiological Health.

d. 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 by decreasing medication costs.

e. Overall, daylit post-surgical facilities improve the mental well-being of patients, thereby improving recover rates.

f. 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.

III. Improved Academic + Cognitive Performance

i. Daylight has been shown to contribute to higher cognitive performance and increased test scores for children.

ii. Studies have shown that students in daylit schools had higher reading and math achievement scores.

iii. "Children in classrooms with the best daylighting...showed higher end-of-year test scores than children in classrooms with no daylight" (Boyce 2003).

iv. 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.

   a. For a closer look at the impact on specific test scores, see Edwards 2002 19-22.

v. Students were reportedly better behaved in better daylit libraries than those with exclusively fluorescent lights.

vi. 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.

vii. The benefits from daylight are distinct from other attributes of windows.

   a. However, it's not just that more daylight is better; the way daylight is delivered is crucial due to the potential for visual and thermal discomfort.

viii. Schools without proper daylighting can reduce students' ability to learn to due the physiological effects of daylight.

   a. Poor spectral quality can cause eyestrain, leading to decreased information processing, learning ability and increased stress.

      1. Higher stress levels can impact certain growth hormones, supporting observations that children primarily under electric lights have a greater risk for decreased mental capabilities, agitated physical behavior, and fatigue,

IV. Reduced Absenteeism

i. Daylight impacts performance by reducing absenteeism through supporting building occupant's health and well-being.

ii. Offices

   a. Lockheed Martin saw a 15% decrease in absenteeism after moving to new daylit offices

   b. Verifone saw an absenteeism reduction of 6.8 hours per person per year, improving attendance rates by 47%

   c. At the International Netherlands Group Bank, limiting desks to within 23 feet of windows caused a 15% decrease in absenteeism.

IV. Reduced Absenteeism cont.

iii. Schools

a. Schools with integrated daylight have increased attendance of both students and staff when compared to more traditionally lit schools.

b. Increased attendance 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).

iv. Industrial

a. Windowless factories saw more absenteeism problems and increased vandalism compared to factories with windows.

1. Providing more access to daylight would be anticipated to help alleviate some of these issues.

V. Decreased Performance

i. More daylight does not always simply translate to better performance; it can decrease performance if improperly or poorly considered.

ii. "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).

iii. Performance speed and accuracy deteriorate in a non-linear manner with reduced visibility.

iv. Problems with luminance contrast, either too much or too little, will also impact task performance.

v. Poorly managed daylight can decrease performance and increase absenteeism through excessive lighting levels, extreme glare, and high thermal discomfort.

vi. Tactics used by employees to cope with the negative problems of uncontrolled daylighting also decrease performance because they distract employees from work and are typically not effective at removing the problem.

a. Ineffective coping strategies are likely to produce dissatisfaction, decreased performance, reduced motivation, and fatigue.

b. Trying to ignore the problem also decreases performance by taking mental energy that could be focused on their work.

VI. KEY REFERENCES

Review Articles

- Boyce, P., Hunter, C. and Howlett, O. (2003) The Benefits of Daylight through Windows. Rensselaer Polytechnic Institute, Troy.
- Edwards, L., & Torcellini, P. (2002). Literature Review of the Effects of Natural Light on Building Occupants
- Ulrich, Roger S, Craig Zimring, Xuemei Zhu, Jennifer DuBose, Hyun-Bo Seo, Young-Seon Choi, Xiaobo Quan, and Anjali Joseph. "A Review of the Research Literature on Evidence-Based Healthcare Design." HERD: Health Environments Research & Design Journal 1, no. 3 (2008): 61-125.

Further Research

- Heerwagen, J.H.; Johnson, J.A.; Brothers, P.; Little, R.; Rosenfeld, A. (1998). "Energy Effectiveness and the Ecology of Work: Links to Productivity and Well-Being." Proceedings of the 1998 ACEEE Summer Study. Washington, DC: The American Council for an Energy-Efficient Economy; pp. 8.123–8.132.
- Heschong, Lisa, Roger L. Wright, and Stacia Okura. "Daylighting Impacts on Retail Sales Performance." Journal of the Illuminating Engineering Society 31, no. 2 (2002): 21-25.
- Heschong, Lisa, Roger L. Wright, and Stacia Okura. "Daylighting Impacts on Human Performance in School." Journal of the Illuminating Engineering Society 31, no. 2 (2002): 101-14.
- Heschong L. "Windows and Offices: A Study of Office Worker Performance and the Indoor Environment." Fair Oaks, CA: Heschong-Mahone Group; (2003).
- Heschong, L., M. Saxena, R. Wright, S. Okura, and D. Aumann, 2004, "Offices, Windows and Daylight: Call Center Worker Performance," Proc. ACEEE Summer Study in Energy Efficiency in Buildings, 22-27 August
- Romm, J.J; Browning, W.D. (1994). "Greening the Building and the Bottom Line: Increasing Productivity Through Energy-Efficient Design," Snowmass, CO: Rocky Mountain Institute.

Popular Press

- "How Tech Giants are Keeping Employees Happy through Innovative Workspaces"- International Business Times
- "Making the Case for Health: Insights from the First WELL Projects" - Urban Land Institute
- "Your Office's Fluorescent Lights Really Are Draining Your Will to Work" - Fast Company