



## KEY POINT SUMMARY

### OBJECTIVES

This study examines how integrating responsive electrical lighting with natural changes in daylight influences staff perceptions of engagement, comfort, and the overall atmosphere.

## An experiment of double dynamic lighting in an office responding to sky and daylight: Perceived effects on comfort, atmosphere and work engagement

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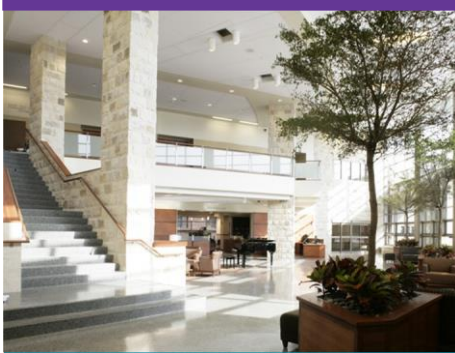
### Key Concepts/Context

Previous research has found that indoor lighting can directly impact staff satisfaction and engagement within the workplace. New technologies allow for “double dynamic” lighting installations that can integrate with natural daylight; however, most studies have examined the effects of other dynamic installations through the use of preset lighting settings. This study suggests that lighting fixtures using sensors which automatically respond to changes in daylight levels can have a positive impact on personnel inhabiting interior spaces.

### Methods

All experiments conducted for this study took place in a university office room painted all white and measuring 4.4 by 5 meters with a height of 2.6 meters. The room also featured two windows measuring 0.8 by 1.07 meters, with southwest-facing views that were unobstructed by buildings. Two pilot studies were conducted to develop seven lighting settings that would respond to variations in daylight inflow, which is defined as daylight intensity measured by a sensor (ESP8266 microcontroller and TCS34725 light sensor) on a work surface, and sky conditions, which were defined as either clear/partly cloudy or overcast as determined by a sky scanner (Zumtobel LM-TLM daylight sensor).

During the main experiment, the office room was occupied with four tables, cabinets, and chairs. All four participants (all males, mean age of 25.5 years) brought their own desk supplies and decorations to customize their workspaces to fit their own preferences. The “double dynamic” fixtures included four tunable and dimmable ceiling panels (2700-6500 Kelvin, Fagerhult Multilume Flat Delta) and



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four spotlights (2700-6500 Kelvin, Zumtobel's Acros 3) using a 36° beam angle and 32° tilt angle.

Data were gathered over four months (eight weeks of static lighting, eight weeks of dynamic lighting) between an autumn and winter season. All data were gathered during working office hours of Monday through Friday from 10 a.m. to 6 p.m.

For the first six weeks of the experiment, bi-weekly electronic questionnaires (using SurveyXact) concerning visual comfort, work engagement, and perceived atmosphere were distributed. During the last 10 weeks, these questionnaires were distributed weekly. Three sessions of in-depth interviews were conducted with each participant, each occurring four weeks following a certain lighting condition.

## Findings

Data from the questionnaires and interviews were analyzed to explore participant perspectives on three themes: visual comfort, perceived atmosphere, and work engagement.

For visual comfort, the dynamic lighting intervention was generally favored, being referred to as “smart” and “adjusting,” while the static lighting period revealed more negative results, with participants noting that it was often too bright and intense, especially during evening hours. These results indicate that implementing different light zones, ambient lighting settings, and task lighting components can contribute to higher levels of visual comfort while still meeting the standardized threshold of 500 lux on working surfaces.

The dynamic lighting was also described more positively with regard to the perceived atmosphere, with participants making several references to how naturally the lighting blended with the daylight. Static lighting was also rated negatively against the perceived atmosphere.

With regard to work engagement, the data revealed that the double dynamic lighting was most effective in October in terms of stimulating concentration, motivation, and aiding with general workflow. The results further imply that having a variety of different light exposures positively affects work engagement. Perceptions of the effect of static lighting on work engagement varied widely, suggesting that offering personalized task lighting with individual controls for color and intensity might be ideal.

## Limitations

This study involved a small sample size of participants. Since this study took place in one specific type of space (an office) and observed a small number of participants who were partaking in relatively similar forms of work, the implications concerning



the effectiveness of dynamic lighting drawn from this study's results may not be applicable to all indoor working environments.

### Design Implications

Double dynamic lighting, or electronic lighting that changes intensity and color in response to natural shifts in daylight, can have a positive effect on the visual comfort, work engagement, and overall perception of the atmosphere among staff working indoors.

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