# Daylight levels affect our thermal perception

September 23 2019

Giorgia Chinazzo. Credit: Murielle Gerber / EPFL

A pioneering study carried out at EPFL shows that the amount of daylight in a room can influence our thermal comfort and how well we tolerate heat or cold. The findings could be used to improve existing building standards and decrease energy consumption.

The difference between reality and our perception of reality has long intrigued Western philosophers. Today scientists at EPFL's Laboratory

of Integrated Performance in Design (LIPID) have shed interesting new light on the subject with a study just published in *Scientific Reports*.

Their research takes a pioneering look at how variations in daylight influence our thermal response. Previous studies on thermal response investigated only the effects of electrical lighting. But the EPFL scientists discovered a significant psychological factor that is associated with daylight and alters how we perceive the thermal environment in a room.

To conduct the study, Giorgia Chinazzo, the lead author, recruited 42 men and 42 women aged 18–25 to take part in an experiment. The participants each spent three hours in a room at one of three ambient temperatures (19°C, 23°C and 27°C) and three daylight illuminance levels (low, medium and high). The illuminance was regulated using color-neutral filters and set randomly for the participants. Participants' body temperatures were also measured continuously during the experiment.

## Distorted perceptions

Participants were not told the purpose of the study so as to not influence their responses. They were instead given tests of cognitive performance (logical reasoning capability, written comprehension, etc.) that included a few questions on thermal perception (did they feel hot or cold) and overall comfort in the room (how they judged the ambient environment in terms of light, temperature, etc.).

It turned out the participants in the 19°C room felt more comfortable and found the temperature more acceptable when the room was filled with daylight—as opposed to having little daylight—even though their body temperatures were the same in both cases. And when the room was warmer, participants felt more comfortable when the room was not as

bright, although, once again, there was no difference in body temperature. That implies the effect is purely psychological.

The scientists then compared their findings with a thermal comfort model developed in the 1970s that is still widely used today. However, that model was developed using data obtained under electrical lighting. The scientists found that, relative to the model's predictions, participants in their study reported a lower thermal sensation—they felt less warm—in the 27°C room when the room was filled with daylight.

## Potential energy savings

Since the main difference between the scientists' study and the model's calculations was the type of lighting involved, these results indicate that the key factor behind participants' lower thermal perception may be the presence of daylight. In other words, the scientists hypothesize that people could better tolerate a warm room if the room is lit with natural rather than artificial light. The scientists believe this may be because in a room filled with sunlight people already expect to feel warm.

The participants' thermal sensations were comparable to a perceived temperature of 1.7°C lower than the actual room temperature. This is a statistically significant difference, and it means that building operators could use less energy to cool their buildings, especially if the buildings are designed to let in a lot of sunlight.

"Our findings suggest that we may be using too much air conditioning—particularly in buildings with glass walls, since the natural light makes the heat more tolerable," says Chinazzo. "If our hypothesis turns out to be correct, buildings could be made more energy efficient by creating additional space for natural light during either the construction or renovation phase. That would also make buildings more comfortable for their occupants."

## Avenues for further research

According to Chinazzo, this study underscores the importance of taking the psychological effects of daylight into account in practice, such as by updating existing building standards. However, she feels more research is needed on thermal perception to confirm these findings and expand on them; this could include evaluating the long-term effects of different daylight levels and testing cultural and seasonal factors.

Chinazzo's thesis, which she defended in March, examined the factors affecting a building's thermal and visual comfort. The paper published in *Scientific Reports* is based in part on her thesis. Chinazzo has also studied how colored window glazing can affect thermal perception and how room temperature can affect perceptions of color and daylight intensity. She has carried out experiments involving a total of over 500 people.

**More information:** Giorgia Chinazzo et al. Daylight affects human thermal perception, *Scientific Reports* (2019). DOI: 10.1038/s41598-019-48963-y

Giorgia Chinazzo, Jan Wienold and Marilyne Andersen, Influence of indoor temperature and daylight illuminance levels on visual perception, *Lighting Research & Technology*, 2019

Giorgia Chinazzo, Jan Wienold and Marilyne Andersen, "Combined effects of daylight transmitted through coloured glazing and indoor temperature on thermal responses and overall comfort," *Building and Environment*, 2018

Giorgia Chinazzo, Jan Wienold and Marilyne Andersen, Variation in thermal, visual and overall comfort evaluation under coloured glazing at different temperature levels, *Journal of the International Colour Association*, 2019

Provided by Ecole Polytechnique Federale de Lausanne