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Occupant perception of “green” buildings: Distinguishing physical and psychological factors

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ABSTRACT

Studies have found a preference bias for “environmentally friendly” or “green” artifacts and buildings. For example, indoor environments are more favorably viewed when the building is labeled/certified “green”, in comparison with one that is not labeled/certified, even though the two environments are actually identical. The present study explored how physical properties of the indoor environment (high vs. low temperature) and labeling (“green” vs. “conventional”) interacts in their effect on environment perception. Participants performed a series of tasks in four indoor environments with different labels (low vs. high carbon footprint) and different temperatures (23 °C vs. 28 °C). Label and temperature were manipulated orthogonally. The participants' environmental concern was also measured. The environmentally concerned participants assigned higher thermal acceptance and satisfaction scores to the environment labeled “low carbon footprint” (i.e., “green” certified) compared to the environment labeled “high carbon footprint” (i.e., not “green” certified), but only in the cooler thermal environment. Environmentally indifferent participants' perception of the environment did not differ depending on label or room temperature. The results suggest that a “green” label positively influence the perception of the indoor environment for occupants, but only when the temperature is within the acceptable range as proposed in guidelines for “green” buildings.

1. Introduction

Buildings have a huge impact on the environment through material use [1], water waste [2], land use [3], but mostly by its energy use as the built environment demands about 40% of global energy [4]. One important response to building's negative impact on the environment is environmental certification [5]. “Green” buildings are better for the environment as they generally are energy efficient [6], water conserving [7], and use environmentally friendly building materials [8]. They also seem to have positive effects for the occupants, for example, “green” buildings are associated with a high workplace satisfaction [9,10] and seem to have psychological [11,12] and behavioral [13] benefits. Furthermore, there seems to be a preference bias for an indoor environment in buildings disclosed as environmentally certified. More specifically, people assign higher comfort ratings to an indoor environment if they are told that the building is environmentally certified, compared to people who rate the same indoor environment without that particular information [14]. In this paper, we seek to explore how physical variations in an indoor environment interact with the preference bias for “green” buildings.

Environmental certifications have had a substantial growth in the 21st century both for residential [15] and non-residential buildings [16]. “Green” buildings preserve natural resources [17,18], mitigate environmental hazards [17,19], improve energy efficiency [6,10], and safeguard the eco-system [20]. The environmental advantage is undeniably the most obvious benefit of “green” buildings, but there exist other advantages as well. For instance, even though there usually is an extra upfront cost for “green” compared to conventional office buildings [21,22], there is some financial gain to be made by making a building “green”. Lau and colleagues [23] found that “green” office buildings can save over 55% of the energy cost compared to conventional buildings, and Ross et al.'s [22] cash flow analysis showed that “green” building design saves more money per square-meter compared to conventional buildings.

Implementation of energy-efficient measures in buildings can also lead to physical changes of the indoor environment [24] and in

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some cases improve the indoor climate for occupants [25]. However, some studies have shown that “green” buildings can be a source of thermal discomfort (e.g., [9,26]). “Green” buildings are often – completely or partly – naturally ventilated. Hence, the temperature inside depends on the temperature outside, which often leads to too hot temperatures in the summer or in warm climates [27,28] and too cold temperatures in the winter or in cold climates [29,30]. This disadvantage in “green” buildings may be crucial, especially in view of the fact that summer temperatures are expected to increase due to global warming [31], and because the thermal environment (a) is of greater importance for indoor environmental satisfaction than other dimensions (e.g., air quality; [32]), and (b) can impair mental work performance [33,34].

In contrast to the disadvantage of thermal discomfort, subjective measures – typically obtained from post-occupancy evaluation studies – suggest that “green” buildings are associated with a high workplace satisfaction [9,10,12,35,36]. For example, occupants of “green” buildings have a greater overall satisfaction with the indoor environment compared to occupants of a conventional building [9,37–39], even when nearly all physical measurements of the two environments are equal [40,41]. The same pattern is found for a more detailed analysis of specific dimensions within the built environment, such as air quality [10,42,43] and thermal comfort [41,43]. There is also evidence suggesting that “green” buildings improve productivity [10,44], performance on cognitive tasks [11] and have the ability to motivate occupants' pro-environmental behavior [13].

The reason why people tend to show a preference for “green” buildings is, however, still unclear. Research in environmental psychology shows that a food product [45–49] or an artifact in the built environment like a desktop lamp [50] is preferred over a conventional counterpart when it is labeled “environmentally friendly”. Eco-labeling of a product is enough to make individuals believe that the product has better features compared to an alternative product labeled conventional, even though the two products, in reality, are identical. The preference bias for eco-labeled products over conventional-labeled products has been found in the context of buildings as well. More specifically, people assign higher comfort ratings to an indoor environment if they are told that the building is environmentally certified, compared to people who do not receive such information [14]. Furthermore, occupants in “green” buildings have higher acceptance (e.g., more tolerance and forgiveness) for an unpleasant indoor environment, compared to occupants in conventional buildings [51,52]; acceptance seems to be related to the occupant's environmental concern [27].

Environmental concern (e.g., affect or worry associated with environmental problems) is based on three different value orientations as proposed by Stern and Dietz [53]. These are biospheric (i.e., concern regarding how the environmental problems will affect the biosphere), altruistic (i.e., concern regarding how the environmental problems will affect other people), and egoistic (i.e., concern regarding how the environmental problems will affect the self) values. Environmental concern has been shown to positively influence several pro-environmental behavior intentions. For example, purchase intentions for ecological products [54], willingness to pay a premium price for renewable energy [55], willingness to pay for green electricity [56], and willingness to take action for mitigating climate change [57]. Previous research within this area has found that altruistic environmental concern is the strongest predictor of the magnitude of the labeling effects. For instance, Sörqvist et al. [50] found that people with high altruistic environmental concern made fewer errors on a color discrimination task when they performed the task under a lamp labeled “environmentally friendly” compared to when the same lamp was labeled “conventional”. Because previous studies have shown that altruistic environmental concern is the stronger predictor of the label effect, the analysis of the current study was, for simplicity, limited to altruistic environmental concern.

1.1. Purpose

Taken together, previous research suggests that physical factors (e.g., temperature) and psychological factors (e.g., associations with “green” labeling) together influence the effects of “green” buildings on occupants. It is yet unclear, however, how these two factors individually influence the occupants and how the factors interact. To explore how the “green” label and temperature interact in their effects on occupant's perception of an indoor environment, bottom-up processes of perception – which depend on the physical characteristics of the stimulus, such as room temperature – has to be separated from top-down processes of perception – which depend on cognitive factors, such as the perceiver's beliefs, desires and expectations with regard to the “green” label.

The purpose of the experiment reported here was: (a) to investigate whether individuals' judgments of perceived indoor environment satisfaction and individuals' judgements of indoor thermal environment acceptance are biased towards a preference for “green” buildings over a conventional alternative, (b) to investigate how room temperature (a physical factor) and “green” labeling (a psychological factor) interacts in their effect on occupant's room perception, and (c) to examine how occupant's environmental concern modulate the interaction between temperature and labeling. To this end, we influenced the bottom-up part of perception by manipulating room temperature in two conditions (i.e., a thermal environment with 23 °C or 28 °C, in two identical rooms). Moreover, we manipulated the top-down part of perception by labeling the two rooms either “low carbon footprint” (i.e., environmentally friendly) or “high carbon footprint” (i.e., conventional), by having the participants believe that one of the two room's indoor environment was managed by an environmentally certified energy system, whereas the other room's indoor environment was managed by a conventional system.

We hypothesized that the participants would be more satisfied with the “green”-labeled room compared to the other room. We also predicted that the participants would be more accepting of the thermal environment in the room with the “low carbon footprint” label compared to the room with the “high carbon footprint” label, especially in the lower thermal environment. Furthermore, we expected that the magnitude of this preference bias for the room labeled “low carbon footprint” would be associated with altruistic environmental concern.

2. Method

2.1. Participants

A total of 78 individuals (50% women) at the University of Gävle (mean age = 25.94 years, $SD = 7.73$) were recruited to participate in the experiment. Four participants of the 78 did evidently not follow instructions and were therefore excluded from the analysis. All participants received a small honorarium for their participation.

2.2. Experimental facilities

The study was conducted in a climate chamber (7.2 m × 8.6 m, ceiling height 2.7 m) at the University of Gävle. The chamber was divided by a wall to make two rooms (room 1: 4.1 m × 7.2 m; room 2: 4.3 m × 7.2 m); configured as two open plan offices, each consisting of 4 workstations (Fig. 1).

Each room had an internal heat load of about 615 W (4 occupants and lighting) and was ventilated with a mixing system. The