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Are Mental Biases Responsible for the Perceived Comfort Advantage in "Green" Buildings?

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Abstract: Previous research has shown that merely calling an indoor environment environmentally certified will make people favor that environment over a conventional alternative. In this paper we explore whether this effect depends on participants deliberately comparing the two environments, and whether different reasons behind the certification influence the magnitude of the effect. In Experiment 1, participants in a between-subjects design assigned higher comfort ratings to an indoor environment that had been labeled "environmentally certified" in comparison with the exact same indoor environment that was unlabeled, suggesting that the effect arises even when participants do not compare the two environments when making their estimates. The results from Experiment 2 indicate that climate change mitigation (as the reason for the certification) is a slightly better trigger of the effect compared to climate change adaptation. The results suggest that studies on psychological effects of "green" buildings should experimentally control for the influence from participants' judgmental biases.

Keywords: eco-label effect; bias; comfort; environmental certification; "green" buildings

1. Introduction

Buildings consume roughly 40% of global energy and influence the environment substantially [1]. Households in the European Union are responsible for 20% of the total GHG emissions [2] and for up to 26% of the total energy consumption [3]. Because of this, the European Parliament have implemented Directive 2010/31/EU, which states that all new buildings—from the 1st of January 2021—in the European Union should incorporate energy saving measures and be "nearly zero energy buildings" [4]. An important step in this endeavor is the environmental certification of buildings [5]. Environmentally certified (or "green") buildings are better for the environment [6]. A perhaps more surprising effect of environmental certification is that "green" buildings also seem to be better for the inhabitants [7,8], as occupants are more satisfied with the indoor environment of "green" buildings compared to a conventional counterpart [9,10]. In addition, one study conducted by Holmgren, Kabanshi, and Sörqvist [11] showed that it is enough to call an indoor environment environmentally certified to make people favor that environment over a conventional alternative, even when the two alternatives are actually identical. In the current paper, we further explore the notion of whether people's biases contribute to the psychological benefits of "green" buildings.

1.1. "Green" Buildings and the Psychological Effects of Environmental Certification

Several countries have developed their own "green" building assessment tools. Examples include The Building Research Establishment Environmental Assessment Method (U.K.), Hong Kong Building Environmental Assessment Methods, Leadership in Energy and Environmental Design (U.S.), Green Star (Australia), and Green Building Label (China). "Green" buildings can be described as "healthy

facilities designed and built in a resource-efficient manner, using ecologically based principles" [12], and they are, compared to conventional buildings, indeed better for the environment, as they preserve natural resources [13,14], protect the eco-system [15], mitigate environmental hazards [13,16], and improve energy efficiency [14,17]. They are also (in some cases) better than conventional buildings in other capacities such as economic [18] and ergonomic dimensions [19,20].

Furthermore, implementation of energy-efficient measures in buildings can lead to changes in the indoor environment [21] and, as stated above, in some cases, improvements in the indoor climate for human occupants [19]. Making a building "green" seems to improve occupants' subjective evaluation of the indoor environment [22], as well as their performance on cognitive tasks [23]. Inhabitants in energy-efficient houses perceive their homes as comfortable, both thermally [24,25] and acoustically [25]. Moreover, employees in "green" buildings and offices have a high overall workplace satisfaction [7], and occupants are more satisfied with the indoor environment of "green" buildings than the indoor environment of a conventional counterpart [9,10,26,27]. It is also important to note, however, that there are studies that show no significant differences between "green" and non-"green" buildings (e.g., [28]). Moreover, "green" building occupants are more forgiving of their buildings (e.g., balancing the good features against the bad; [29]). This tolerance for bad building features seems to be related to people's degree of environmental concern [30]. There are also studies suggesting that "green" buildings have the ability to improve work productivity [8,31]. There is, however, research that challenges the claims regarding improvements of productivity [32], which might be due to certain biases in self-evaluation measures (e.g., questionnaires; [33]).

Collectively, the studies of the psychological benefits of "green" buildings are promising, but it is yet unclear how the participants' expectations and stereotypical beliefs about "green" buildings bias these self-reported subjective evaluations of the indoor environments. Environmental psychology research shows that it is enough to label a consumable product [34] or an artifact such as a desktop lamp [35] "environmentally friendly" to make people favor this alternative over another alternative labeled "conventional", even when the two alternatives are actually identical. For example, people prefer the taste of a cup of coffee labeled eco-friendly to a cup labeled conventional, even when the two cups contain the exact same coffee [34]. This eco-label effect is a robust phenomenon and has been replicated many times (e.g., [11,36–39]). The eco-label effect is a specific instance of a phenomenon called the "placebo effect" [40], whereby an effect arises from a manipulation because people believe the manipulation has an effect, not because the manipulation actually has an effect (see also "framing effects"; [41]).

An eco-label effect has also been shown for labeling of the built environment. For example, people assign higher comfort ratings to an indoor environment called environmentally certified compared to an indoor environment called conventional, even when the two environments are, in fact, identical [11]. Hence, it may well be that the "green" building label attached to environmentally certified buildings also triggers expectations and preconceptions that bias the psychological assessment of the buildings. The vast majority of studies measuring psychological effects of "green" buildings (e.g., [7,22,24,25]) have, to the best of our knowledge, not had experimental control over the potential influence of these biases. Because of this, the reason why people report psychological benefits from their experiences with "green" buildings could be, at least in part, because they believe in these benefits rather than actual benefits.

1.2. Purpose

Drawing on the work of Holmgren et al. [11], the purpose of this study was to further investigate whether the subjective evaluation of an indoor environment is biased such that people say they prefer the indoor environment of a building they believe is environmentally certified. Specifically, we explored whether this effect arises using a between participants design (Experiment 1). Most (if not all) previous studies on the eco-label effect have employed a within-participants design wherein the participants make estimates of both the "eco-labeled" and the "conventional" alternative. This procedure

encourages the participants to compare the two alternatives when making the estimates. The point with using a between-subjects design, wherein the participants only make estimates of either the "eco-labeled" or the "conventional" alternative, is that this comparison is not reinforced by the experimental procedure. The present series of experiments also explored whether different reasons behind the certification influence the magnitude of the effect (Experiment 2).

2. Experiment 1

The purpose of Experiment 1 was to test whether the label effect arises in a between-subjects design. The participants were allocated to one of two conditions: half of the participants were assigned to a framing condition in which the participants were told that the building they were in was environmentally certified (hereinafter referred to as the *framed condition*), and the other half was assigned to a control condition, which had no framing (hereinafter referred to as the *control condition*). We hypothesized that there would be an effect of labeling the building "environmentally certified" on perceived overall comfortableness. More specifically, we hypothesized that the participants in the framed condition would rate the indoor environment as overall more comfortable compared to the participants in the control condition, even though the two participant groups evaluated the exact same indoor environment.

3. Method—Experiment 1

3.1. Participants

A total of 42 students recruited at the University of Gävle (64% women) participated in the experiment (mean age = 24.67, *SD* = 4.22). They all received a small honorarium for their participation. The study was approved by the Research Ethics Review Board at Uppsala University (Dnr 2015/475). Oral consent was considered to be sufficient by the ethics review board. The data collectors took note of the oral consent.

3.2. Materials

A questionnaire was used to obtain data. On the first page of the questionnaire, all participants (in both conditions) were told that the University had implemented a survey regarding how students and personnel perceive the University's premises in terms of comfortableness. For half of the questionnaires (i.e., the "framed condition"), the following statement was also added to the introductory text: "*The laboratory, where you are now, is environmentally certified according to ISO 14001 and is provided with environmentally friendly electricity, ventilation and heating. The vision of the University of Gävle is to strive toward a sustainable growth within all its practices, and the University's business should be conducted in such a way that the positive impact on the existing environment increases and the negative impact decreases*". For the other half of the questionnaires (i.e., the control condition), no such information was provided. After reading the introductory texts, the participants rated overall perceived comfortableness in the room in which they were presently sitting, on a scale ranging from 1 (i.e., not at all comfortable) to 7 (i.e., very comfortable). In the "control condition", the question was: "*How comfortable would you say the room is, generally?*" In the "framed condition", the question to respond to was: "*How comfortable would you say the* ***environmentally certified*** *room is, generally?*" (The bold text was added to highlight the difference).

3.3. Design and Procedure

A between-participants design was used with framing as the independent variable with two levels: framing of the indoor environment as "environmentally certified" versus a no-framing control condition. The participants were randomly distributed across the two conditions. This randomization resulted in a sample of 12 women and 9 men in the framing condition and 15 women and 6 men in the control condition (the two conditions were highly matched with regard to participants' age).

The experiment took place in a laboratory at the University at Gävle and was part of a larger data collection on research questions without relation to the current research questions. Two identical rooms were used, and the two rooms were used an equal number of times in both conditions. The participants sat alone in the laboratory room when making the estimate and responded to the questionnaire. Each participant had spent approximately 45 min in the room before responding to the questionnaire.

4. Results and Discussion—Experiment 1

The participants in the framed condition perceived the overall comfortableness of the room as greater (M = 5.62, SD = 0.92) than the participants in the control condition did (M = 4.52, SD = 1.44). This result was statistically significant, as shown with the one-way analysis of variance across the two conditions, $F(1, 40) = 8.66$, $p = 0.005$, $\eta_p^2 = 0.18$. Hence, the results from Experiment 1 suggest that self-reported estimates of indoor environments are more favorable when the person making the estimates thinks (or knows) that the building is environmentally certified. This finding replicated the effect showed by Holmgren et al. [11] and showed that the effect can arise in the context of a between-participants design wherein the participants do not compare the two environments, in contrast to a within-participants design.

5. Experiment 2

The purpose of Experiment 2 was to replicate the main finding from Experiment 1 and to explore whether the magnitude of the label effect depends on what the participants think is the reason behind the "environmental certification". To cope with global warming, scientists and policymakers have pointed at the importance of interventions that *adapt to* the climate change and *mitigate* the climate change [42–44]. Social interventions that can be used to mitigate (slow down) climate change are, for example, promotion of green consumption [45] and promotion of recycling [46]. The climate change discourse has, over the last decades, had its focus on climate change mitigation. However, as the effects of climate change already are occurring [42], it is also important to consider possibilities to adapt to climate change, for example by implementing new technological solutions that can cope with the impacts of global warming. As implementations of both of these environmental policies—mitigation and adaptation—are essential to cope with climate change, it would be interesting to test whether people's beliefs about climate change mitigation and adaptation (as different reasons for the environmental certification) influence the magnitude of the "green" label effect on perceived comfort. To test this, some participants in Experiment 2 were told that the "environmental certification" was a result of mitigation interventions (measures taken to slow down climate change), while others were told that it was a result of adaptation interventions (measures taken to adapt the building to climate change). As climate change mitigation is more familiar to the public than climate change adaptation, and because adaptation has had a bad reputation in the past [47,48], we hypothesized that the participants in the mitigation condition would be more susceptible to the "green" label effect on perceived overall comfortableness compared to the participants in the adaptation condition.

6. Method—Experiment 2

6.1. Participants

A total of 135 students recruited at the University of Gävle (49% women) participated in the experiment (mean age = 25.29, SD = 6.21). Students were invited to take part in the study when they had arrived to their classroom prior to lectures. The study was approved by the Research Ethics Review Board at Uppsala University (Dnr 2015/475). Oral consent was considered to be sufficient by the ethics review board. The data collectors took note of the oral consent.

6.2. Materials

The questionnaires were identical to those in Experiment 1, except for the information provided prior to the comfort rating. One third of the questionnaires framed the environmental certification as a result of mitigation interventions: "*The University of Gävle's vision is to* ***mitigate*** *the current climate change through the built environment. Examples of how the University of Gävle* ***mitigates climate change*** *are: installation of solar films on the windows and painting the roofs in a lighter color to alleviate the load on the air conditioning, and installation of solar panels that supply the University with natural energy. These* ***mitigation actions*** *have made the room where you are now are sitting environmentally certified according to ISO 14001*." One third of the questionnaires framed the environmental certification as a result of adaptation interventions: "*The University of Gävle's vision is to* ***adapt*** *the built environment to the current climate change. Examples of how the University of Gävle* ***adapts to climate change*** *are: installation of solar films on the windows and painting the roofs in a lighter color to alleviate the load on the air conditioning, and installation of solar panels that supply the University with natural energy. These* ***adaptation actions*** *have made the room where you now are sitting environmentally certified according to ISO 14001*." The questionnaire distributed in the control condition was identical to the one in the control condition of Experiment 1.

6.3. Design and Procedure

A between-participants design was used with framing as the independent variable with three levels: two "environmentally certified" framing conditions, in which the participants were told that the certification was either a result of mitigation (N = 46) or of adaptation interventions (N = 46), and a control condition (N = 43). The experiment took place at the University at Gävle. The participants were randomly distributed across conditions. This randomization resulted in 21 women and 25 men in the adaptation condition, 28 women and 18 men in the mitigation condition, and 17 women and 26 men in the control condition (age distribution was highly matched between conditions). The participants sat in a classroom, and they were invited to take part in a survey on perceived comfortableness in classrooms. The three different questionnaires were distributed among the students in the classroom who were willing to participate. Participants next to each other received the same type of questionnaire to prevent them from noticing that other participants had received a questionnaire that was different from the one they had received themselves. The data collection was repeated a number of times in different classrooms with different classes. The participants had spent approximately 15 min in the classroom before making the evaluation. The three questionnaires were equally distributed within each class and classroom.

7. Results and Discussion—Experiment 2

As can be seen in Figure 1, the participants perceived the classroom as more comfortable in the mitigation condition compared to the control condition, whereas there was only a tendency for perceiving the room as more comfortable in the adaptation condition compared to the control condition. There was no difference between the mitigation and the adaptation condition. A one-way analysis of variance across the three conditions was calculated with overall comfortableness ratings as the dependent variable. The analysis revealed a significant difference between conditions, $F(2, 132) = 3.51$, $p = 0.033$, $\eta_p^2 = 0.05$. Independent samples t-tests revealed that the participants in the mitigation condition (M = 4.91, SD = 0.96) perceived the classroom as more comfortable than did the participants in the control condition (M = 4.42, SD = 0.73), $t(87) = 2.72$, $p = 0.008$, $\eta^2 = 0.08$. The classroom was also perceived as more comfortable in the adaptation condition (M = 4.77, SD = 0.99) compared to the control condition (M = 4.42, SD = 0.73), but this difference was not statistically significant with the conventional alpha threshold, $t(87) = 1.91$, $p = 0.059$, $\eta^2 = 0.04$. No difference was found between the mitigation and the adaptation condition, $t(90) = 0.69$, $p = 0.490$, $\eta^2 = 0.01$.

Experiment 2 revealed a framing effect on perceived overall comfortableness, congruent with Experiment 1 and previous research [11]. The framing effect appeared somewhat stronger

in the mitigation condition, but there was no difference between the two framing conditions. Because of this, the safest conclusion from Experiment 2 is arguably that the psychological evaluation of environmentally certified buildings is biased, but the reason for this environmental certification—mitigation or adaptation—has only marginal effect.

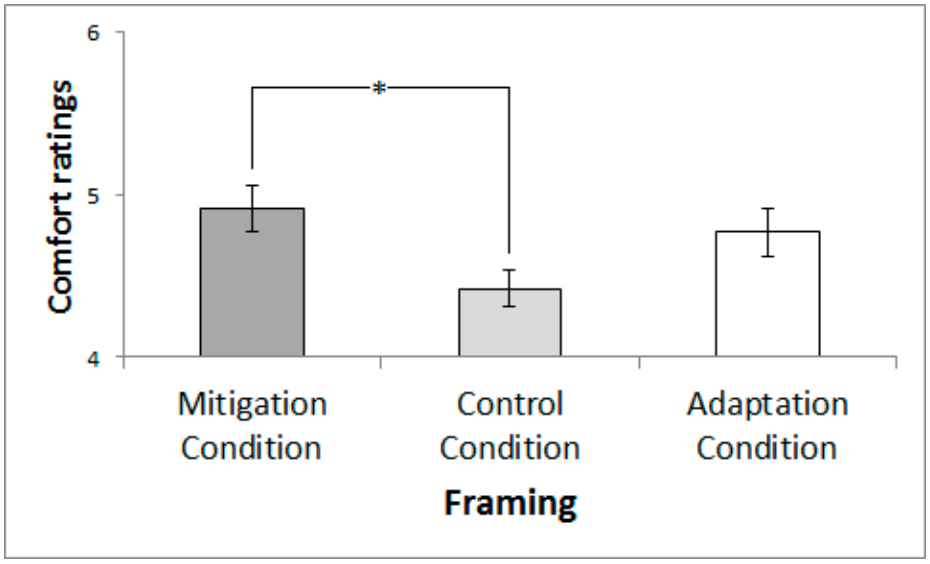

Figure 1. Mean perceived overall comfort ratings assigned to a classroom in a building. The participants were either told that a mitigation intervention or that an adaptation intervention had led to the building being environmentally certified or they were not at all told that the building was environmentally certified. Error bars represent standard error of means. Note: * Significant at alpha = 0.05.

8. General Discussion

In Experiment 1, participants assigned higher comfort ratings to an indoor environment labeled "environmentally certified" in comparison with the exact same but unlabeled indoor environment. Experiment 2 replicated the results from Experiment 1 and found that the magnitude of this preference bias for environmentally certified buildings is quite insensitive to the reasons for the certification. If anything, the strongest effect was found when the participants were told that the reason for the environmental certification was climate-change mitigation.

A large body of studies have measured potential benefits to be gained from working or living in "green" buildings by obtaining self-reports from participants [7–10,22,26,27,49]. As shown here, these self-reports are sensitive to framing effects and may therefore be unreliable as a measure of the "green" building benefits for the inhabitants. What seem to be psychological benefits from engineering interventions of buildings may reflect the consequences of people's biases and beliefs about environmental certification rather than effects of physical differences between the built environments.

It should be stated that our intention here was not to conclude that all benefits for occupants in "green" buildings simply are a consequence of the occupants' biases. Allen et al. [23] showed, for example, that occupants obtain higher scores on cognitive tasks when the tasks are conducted in "green" buildings compared to in conventional buildings, even when the participants were blinded to what condition they were in (i.e., the participants did not know whether they conducted the task in an indoor environment of a "green" or a conventional building). We rather conclude from the present study that people's biases influence the magnitude of the effects associated with "green" buildings, something that calls for the need to control for this issue in scientific endeavors in the future.

It is important to stress that even though a placebo-like effect improves people's perception of the indoor environment of "green" buildings [11], due to their expectations and biases, the feelings of greater comfort in "green" buildings may still be "real". In other words, people are more comfortable

in environmentally certified buildings, even though the effect may surface through their expectations rather than through a physical difference between "green" and "conventional" built environments. It is possible, for example, that the perception of a room as more comfortable, because of a "green" building label, is beneficial for learning abilities and health, similar to actual high-quality indoor environments [50,51].

A step towards understanding how to enhance the psychological benefits of environmental certification was taken in Experiment 2. This experiment indicated that a mitigation frame could potentially be an efficient trigger of the label effect. A possible explanation for the slightly stronger effect of the mitigation framing, in comparison with the adaptation framing, is that adaptation to climate change has had poor reputation [47,48] compared to mitigation. Thus, participants might have felt slightly more indifferent toward the framing information regarding the University's vision to adapt to climate change when told this was the reason for the certification. Additionally, as the climate change discourse over the last decades has had its focus on climate change mitigation, adaptation could have been a new concept to the participants and was perhaps therefore not an efficient trigger. Furthermore, environmental concern [11,35] and attitudes toward behaviors that mitigate climate change (e.g., pro-environment consumer behavior; [34,37]) co-vary with the magnitude of the eco-label effect (e.g., the tendency to report that the lighting from a light source is more comfortable when the light source is labeled "environmentally friendly" compared to when the same light source is labeled "conventional"). Additionally, it is probable that the mitigation frame is more appealing to people with high environmental concern than the adaptation frame, making the effect of the mitigation frame somewhat stronger. It should be noted, though, that no significant difference between the mitigation and the adaptation frame conditions was obtained in the present study.

On a methodological note, it is worth mentioning that previous studies on the eco-label effect have consistently used a within-participants design, in which the same persons evaluated both an "eco-labeled" and a "conventional" (or non-labeled) target (e.g., [11,35,37,38]). This procedure, in which the same person is making estimates of two products, encourages a comparison between the "eco-labeled" and the "conventional" alternative, and this encouragement may exaggerate the differences between the two alternatives in the self-reported estimates. Conversely, the present study used a between-participants design in which the participants who were asked to evaluate the "environmentally certified" environment were not the same as those who evaluated the non-labeled environment. As shown in the current study, the eco-label effect is robust and reliable enough to arise even in a between-participants design in which the participants do not compare the two alternatives. This finding may also be of practical importance, because this robustness of the effect shows that the psychological framing effects of environmental certification may appear even when people are not comparing certified and non-certified buildings.

8.1. Limitations of the Study and Directions for Future Research

The current study is (to our knowledge) the first to show the "green" label effect in the context of a between-participants design. The study has, however, some limitations: (1) the sample sizes were quite small (especially in Experiment 1), (2) the participants were university students, and (3) the settings were either two rooms in a laboratory or classrooms. Studies regarding occupant satisfaction in "green" buildings are usually conducted in office buildings, with office workers as respondents and with larger sample sizes compared to what was used in the present study (e.g., [52–54]). Even so, past research has also looked at comfort in "green" university buildings [49,55].

Furthermore, there was no control for the potential influence of clothing and metabolic rate in the current study. These factors can influence perceived comfort [56]. Another limitation of the current study is that the only dependent measure was overall comfort. Comfort in the indoor environment is determined by sub-variables; for example, air quality [57], thermal [58], acoustic [59], and visual comfort [60]. These variables were not treated individually in the current study. Furthermore, environmental concern is related to acceptance for an unpleasant indoor environment in "green"

buildings [30], and people with high environmental concern are more susceptible to the eco-label effect (e.g., [11,34]). Given the information above, to achieve a more comprehensive understanding of how the environmental certification label influences indoor environment perception, and to investigate how generalizable this effect is, future research should control for the previously mentioned variables, include additional dependent variables, and consider replicating this study with larger sample sizes, different demographic variables, and different settings. Targets for future research also include investigation into whether reasons for environmental certification, other than mitigation and adaptation to climate change, can influence the magnitude of the effect.

8.2. Conclusions

The bias toward a preference for environmentally certified buildings appears to be small but reliable and appears across different environmental settings and experimental setups. This conclusion stresses the need to control for this bias when investigating the psychological benefits of "green" buildings.

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Conflicts of Interest: The authors declare no conflict of interest.

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