Influence of LEED Branding on Building Occupants' Pro-Environmental Behavior

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ABSTRACT

In this paper, we examine the influence of branding a building as LEED certified on occupants' pro-environmental behavior (individual participation in an activity that promotes sustainable (green) practices by reducing or eliminating negative environmental impacts). Branding is defined as identifying a building as LEED certified and emphasizing the aspects of the building's green features to its users. One hundred participants were randomly assigned to one of the two experimental groups: (1) the branding group, in which the building was branded as being LEED certified, and (2) the control group, in which no information was provided about the building being LEED certified. Through the use of an immersive virtual environment, two examples of pro-environmental behaviors were examined between the two groups: participants' choices in using natural light vs. artificial light for increasing the lighting levels in the room, as well as their choices of recycling bin vs. regular trashcan for placing scrap paper. The results show that the participants in the branding group chose natural light and recycling bin significantly more than the participants in the control group, suggesting that LEED branding motivates occupants' pro-environmental behaviors. The results also show that participants' environmental values and views had significant effects on the influence of LEED branding. The results also suggest that increasing building occupants' knowledge about environmental issues might improve their pro-environmental behaviors.

Keywords: *Green branding; LEED; Design features; Energy consumption behavior; Environmental concern; Immersive virtual environment, Sustainability, Architecture*

1. INTRODUCTION

Residential and commercial buildings steadily increased their shares in energy consumption, reaching 41% of the total energy consumption in 2014 in the United States [1]. Advances in building technology and science have made it possible to reduce buildings' negative impacts on the environment by employing sustainable building practices. In recent years, rating systems and certification programs have been developed in an effort to provide the Architecture, Engineering and Construction (AEC) industry with the tools necessary to design and construct high performance green buildings [2]. Among these certification programs, Leadership in Energy and Environmental Design (LEED) green building rating system is used increasingly in the United States. LEED was developed by the United States Green Building Council (USGBC) to provide nationally accepted third party certification that a building is designed and built using an approach that reduces or eliminates negative environmental impacts. LEED provides four levels of certification: certified, silver, gold, and platinum which are based on a building's performance, measured using a set of prerequisites and credits (standards). "Each higher level of certification represents an incremental step toward integrating different components of sustainable design, construction, and operation to achieve optimal building performance [3]." The LEED standards aim to

create a specific kind of built environment that consumes minimal resources and also produces minimal waste [4].

Energy efficient design strategies have been increasingly adopted in office buildings, which make up a large portion (in terms of gross area) of LEED-certified buildings [5]. Company policies that geared toward environmental stewardship [6], stringent building codes and government regulations [7], cost effectiveness, utility incentives, and occupant productivity [8] and satisfaction [9] are among the reasons that motivates an organization to occupy LEED certified office buildings. However, paired comparisons of the energy use of LEED certified buildings with similar conventional buildings showed that although energy performance for LEED-certified buildings was better on average, many individual LEED buildings performed worse than their conventional counterparts [10]. One possible cause of this underperformance is the behavior of occupants of LEED buildings [11,12]. These buildings might have sustainable designs, however, their occupants might not have adopted pro-environmental behaviors if there was no provision of information for sustainable usage. Pro-environmental behavior is defined as individual participation in an activity that promotes sustainable (green) practices by reducing or eliminating negative environmental impacts [2]. One suggested approach is for building occupants to change their energy consumption behavior by adopting more pro-environmental behavior, such as adoption of natural light instead of artificial light. In previous studies, researchers have used intervention strategies in green buildings to influence occupants' behaviors. For example, occupants' behaviors were influenced by increasing occupants' knowledge (e.g., knowledge about how a building system works or how much energy it consumes), which can convince occupants to change their behavior [13]. However, it has not been investigated to date if knowing a building is LEED certified influences occupant behavior in a positive or negative manner.

In this study, we specifically examine the influence of LEED branding, as an intervention strategy, on building occupants' pro-environmental behavior, specifically lighting preferences and recycling behavior in office buildings. LEED branding, in this paper, is defined as developing a green image of a building by introducing the building as being LEED certified. Office buildings present great opportunities in energy reduction due to their large share in total commercial buildings' energy consumption (19% [14]), occupants' lack of direct financial incentives for energy conservation, and the average time that a person spends in an office building (7.8 hours per day [15]). The following sections of the paper include a review of previous studies on occupant behavior in green buildings and different factors that can influence occupant behavior in a building. Then, the paper continues with a description of the research methodology, followed by an analysis of the data gathered through the use of immersive virtual environment (IVE). Finally, a section including a discussion around the results, limitations of the work, future plans, and conclusions of the study is provided.

2. OCCUPANT BEHAVIOR IN GREEN BUILDINGS

When performance of green buildings are considered, the majority of the previous research focused on how green features, used in the design of green buildings, can promote productivity, well-being, satisfaction, and comfort of occupants or support the possibility of organizational financial gains [3,16]. However, it is important to recognize that the benefits of green buildings are more likely to occur when the building and its occupants are treated as an integrated system [8]. Many researchers acknowledge the important role that occupant behavior plays in buildings' energy consumption [17-20]. Some argue that occupant behavior is a key reason for the large gap between the expected and actual energy consumption and efficiency of a building [21]. Although technological improvements can have an impressive influence on how the built environment impacts the natural environment, studies have shown that green office buildings could consume more energy in comparison to conventional office buildings of the same function and size [22,23]. This underperformance might result from the differences between assumed and actual patterns of occupant behavior [24]. Buildings use energy to support occupants' activities. Although

green design is important in reducing building's energy consumption, it is also the building occupants that influence a building's performance [25]. Many of green solutions, such as individual heating controls, window shades, and waste reduction policies, are controlled/implemented by the occupants and affected by their behaviors [13]. Therefore, in LEED certified buildings, although green policies and services are in place, they are only successful when implemented and conformed correctly by the occupants of the building [26].

Some argue that occupants in green buildings adopt pro-environmental behaviors more than the occupants in conventional buildings [27,28]. For example, Steinberg et al. [28] conducted a survey investigating occupants' willingness to adopt more pro-environmental behaviors in a new green building and in a conventional commercial building. The results showed that the occupants anticipating to move into a new green building showed more willingness to adopt pro-environmental behaviors as they were encouraged by the green building certification and wanted to ensure the building consumes less energy. In addition, Azizi et al. [27] conducted a survey to investigate the level of pro-environmental behavior between green and conventional office buildings in Malaysia. The results of their study showed that occupants in green buildings adopted more pro-environmental behaviors than occupants in conventional buildings because of the intervention strategies implemented in the green buildings, such as putting up posters on energy efficiency features of the building. The results of another survey conducted by Azizi et al. [29] showed that occupants in the LEED certified office buildings were more willing to sacrifice their comfort and adopt more pro-environmental behaviors in comparison with the occupants in conventional buildings. For example, in response to being cold, the occupants in green buildings adopted more personal adjustments and less environmental adjustments compared to occupants in conventional buildings. The authors suggested that the perception of working in green buildings could be the reason to influence occupants' behaviors towards more green behaviors. These studies showed that green buildings promote more pro-environmental behavior among the occupants (conformity).

However, there are also studies that show green buildings do not motivate occupants' pro-environmental behaviors. It is possible to have a "green" building with "gray" occupants, who are not environmentally conscious, due to the lack of knowledge about how to use the building systems in the most efficient and effective way [30]. Gray occupants are also more likely to be found in green buildings due to the "rebound effect" or "take back", which is the term used to describe the effects caused by energy efficiency improvements. For example, a study showed that when the recycling option was available, people increased usage of products that were free (e.g., office paper, bathroom paper towels, etc.), creating adverse effects [31]. A reason for this kind of behavior might be the fact that a green building might be considered as remedy to relieve the negative emotions, such as guilt associated with wasteful behavior and disposing of a product [32]. Another reason might be the "licensing" effect, which suggests that a prior environmentally responsible choice affirms individuals' values of social responsibility and ethical consciousness; therefore, it can license less environmentally responsible and morally questionable behavior in a subsequent choice [33]. "Greenness" of a building might also seem as a remedy, which undermine occupants' risk perceptions and increase their intentions to use more energy [34]. In other words, occupying a green building might be considered as a remedy for the occupants and license them for less environmentally behavior as they feel that the building's sustainable features will compensate for their wasteful behavior (compensation). Therefore, it is possible that occupants in green buildings behave in a more wasteful manner. In other words, being an occupant of a green building may have the unintended consequence of increased consumption [35].

Studies also suggest that there is a relationship between green consumption and an individual's environmental attitudes (values and views). For example, Thøgersen and Olander [36] found that sustainable consumption patterns are influenced by individual value priorities. Roberts [37] investigated the potential demographic and attitudinal correlation among the ecologically conscious behavior. The results of his studies showed that the perceived effectiveness (the belief that consumers, as individuals,

can help solve environmental problems) was found to be the best predictor of ecologically conscious behavior. In another study, Karp [38] investigated the influence of values on environmental behavior and found that altruistic values have positive influence on environmental behaviors. Azizi et al. [39] suggested that energy awareness and knowledge around the existing solutions to the environmental issues could be the motivating factor for occupants to practice pro-environmental behaviors. In addition, occupants need to have knowledge and skills to engage in these practices. In summary, the attitudes and behaviors of a green building's occupants can significantly affect a building's performance during the building's life [40]. Sustained progress in green buildings results from understanding of sustainability values of the building and occupants' engagement with them. Without proper engagement, occupants might alter the way in which the building is designed to operate [41].

3. RESEARCH OBJECTIVES AND QUESTIONS

To the best of our knowledge, there is no empirical research that has investigated the influence of LEED (green) branding on energy consumption behavior of building occupants. Therefore, the objective of this study is to investigate the influence of LEED branding on occupants' pro-environmental behaviors in a single occupancy office space. Specifically, we aim to answer the following two questions through this work:

1. How does LEED branding influence building occupants' pro-environmental behaviors (i.e., natural light vs. artificial light preferences and recycling behaviors) in a single occupancy office space? We specifically investigate if LEED branding influences occupant behavior in a positive way, which means that occupants conform to the green building's standards (conformity); or occupants would feel that the building is handling environmental concerns and therefore it could compensate for their wasteful behavior and this would result in negative environmental behavior (compensation).
2. How do environmental values and views affect the influence of LEED branding on lighting preferences and recycling behaviors?

In order to create a successful LEED branding strategy, we focused on the functional attributes as well as the emotional benefits of the LEED certified buildings [42]. To include the functional attributes, we delivered information on how LEED certified buildings are designed to reduce the environmental impacts. In addition to enhancing the influence of LEED branding, we tried to evoke positive emotions in the occupants by offering information on how LEED certified buildings contribute to human health and preservation of the natural environment. LEED branding was implemented by labeling the building as being LEED certified while explaining the LEED certification procedure, its environmental goals and contributions to the natural environment and human health, as well as LEED certified building's standards, sustainable aspects of their design, construction, and operation.

4. RESEARCH METHODOLOGY

To study occupant behavior in general and occupants' interactions with buildings, many studies used field data collection techniques, such as field experiments along with survey methods to collect occupant-related data [43,44]. Although performing such experiments is possible in existing buildings, there are several factors that could affect the results. Since we are studying LEED branding and its effects on occupants' behaviors when a building is presented as a LEED certified building, we have to identify and control a LEED building's design features. To be able to collect actual occupant-related data, we also need access to actual LEED certified buildings with specific LEED features, which is challenging. Furthermore, uncontrollable factors, such as cloudy/sunny weather in different days or different window types, which influence the level of natural light in a room, might affect the results by causing experimental noise. In addition, there could be various variables in the design of interventions, which result in different scenarios to take place in different environments (e.g., different indoor layouts, materials, all of which might impact occupants' behaviors).

To address these issues, in this study, we have utilized Immersive Virtual Environments (IVEs) to simulate a real-life office setting. Several studies found IVEs to be valuable tools to study human behavior [45-47]. Despite the differences between virtual interactions and physical interactions, researchers successfully use IVEs to answer questions that cannot be easily addressed just using traditional surveys [46], which are the tools that are used most frequently in the research for gathering data on behavior. Research has shown that users act in similar ways within IVEs as they do in physical environments and have similar feelings of presence within such environments [43,47-49]. IVEs allow the users to feel immersed within the virtual space as if they were in a physical space. In addition, IVEs give the experimenter the ability to quickly and easily change an environment's settings (e.g., lighting settings, architectural and interior designs, etc.) to test different scenarios while maintaining high experimental control, which is hard to accomplish in physical environments mainly due to coupled variables and physical limitations. For example, IVEs allow the experimenter to control for the potentially confounding variables and isolate the variables of interest (e.g., branding) while providing the same environment for all the participants (e.g. same level of lighting). Another significant advantage of IVEs is that participants cannot see the experimenter so they do not feel like the experimenter is watching and/or judging them and it results in behavior that is less reserved or more realistic [50]. Therefore, we used IVEs in our experimental design as explained below.

Design of experiment and hypothesis

A virtual model of a single occupancy office was created in an IVE (Figure 1). The modeled office included the following features: both natural light and artificial light sources, controllable blind and controllable lighting fixtures, two trash storage bins, a recycling bin and a regular trashcan. The participants were able to interact with the environment by turning on/off the lights, opening/closing the blinds, and grab and move the objects.

Figure 1 – Different views of the model: (a) Top view, (b) perspective view

Participants were randomly assigned to one of the two experimental groups: branding group: information was provided to the participants about “green buildings” and LEED certification (its functional attributes and emotional benefits) and the room was introduced as being part of a LEED certified building; and control group: no information was provided to the participants about the room being LEED certified or having any green features. The only difference between the two groups’ models was the inclusion of LEED certification signage on the door (LEED group).

We tested the following hypotheses by comparing the participants’ behaviors between these two groups:

- H1: When placed in a dark room, participants in the branding group would choose natural light to increase the lighting levels significantly more than the participants in the control group (conformity).
- H2: When asked to place the scrap paper in a trash can, participants in the branding group would choose recycling bin significantly more than the participants in the control group (conformity).
- H3: LEED branding would be more influential on lighting preferences and recycling behaviors of the participants with higher environmental values and views compared to the participants with lower environmental values and views.

To test these hypotheses, experiments were conducted in IVEs for a period of three months (March 2015 through May 2015). First, a pilot study was conducted with a limited number of participants to ensure that the model, procedure, and the questionnaires were designed adequately for the experiment. Based on the findings of the pilot study, we modified the immersive virtual environment and the questionnaires that were administered after the experiment. A power analysis was conducted and it was determined that 88 participants in total were needed to have close to 80 percent power to detect statistically significant effects in differences between the two conditions. We had 50 participants for each condition ($n = 100$ participants) resulting in 85 percent power. Participants were undergraduate and graduate students at the University of Southern California. Participants either voluntarily participated in the experiment or received course credit or incentives (e.g., pizza) for their participation. Prior to participating in the experiments, participants were asked to read and sign a consent form.

Modeling and Experiment Setup

The architectural geometry (e.g., walls, generic windows, ceiling, and light fixtures) of a 3D model of a single occupancy office space was first created in Revit[®] 2015 and then taken to 3ds Max[®] to optimize the geometry and add materials, furniture, texture, lighting, reflection, and shadows and in order to make it look more photo realistic (Figure 2).

Figure 2 - Modeled environment in 3DMAX[®]

The model was then exported as an FBX file and imported to the Unity[®] game engine, where interactive options (e.g., opening/closing blind animation, turning on/off lights animation, ability to grab objects) were programmed into the model in a way that would allow the participants to have more realistic interactions with the virtual interactive model. For example, participants were able to turn lights on/off by standing in front of the light switch or open/close the blind by standing in front of a window. Through Unity[®], it was possible to connect the 3D models to the IVE equipment. We used Oculus DK2 Head-Mounted Display (HMD) to provide a fully immersive environment that included an Xbox-360 controller, and a positional tracker that would track the participants' head and neck movements (Figure 3).

Figure 3 - Modeled office - illustrating what participants see through Oculus DK2 Head-Mounted Display

Pre-Experiment Session

Prior to the experiment, participants underwent training to become more familiar with IVEs. The training was done in a different environment than the experimental one in order to avoid any learning effects and biases that could possibly affect the participants' decision making during the experiment, as well as to reduce any noise that would influence the experimental results other than the experiment manipulations (Figure 4). The training included showing the participants how to: work with the equipment, put the head mounted display on and adjust it to their most comfortable state; move around in the immersive virtual environment; turn on/off the lights; open/close the blinds; read text; and grab and move the objects in the space. In addition, we showed them how the lighting levels would be if they open the blinds or turn on the lights, so that the participants knew that there would be enough light to read the passage in both settings (natural light or artificial light). In addition, all participants, both in Group 1 and 2, were told that the study was about how to link Building Information Models (BIM) to immersive environments to be incorporated in architecture and engineering courses and the participants input was going to be used to understand how realistic these virtual environments were compared to the actual and/or BIM environments.

Figure 4. Training process: a participant is trained how to navigate and interact within the IVE. The left image shows the participant navigating through the room, and the right image shows the participant opening and closing the oven door

Then, the participants were told that they would be placed in the middle of an office room (starting equal-distant to both the light switch and the blind) and they would have to walk around the desk to read a passage, which was located on a monitor placed on the desk. Participants were told that they could ask the experimenters to stop the experiment whenever they experienced motion sickness. The participants were randomly assigned to one of the two experimental groups: the branding group and control group. The participants in the branding group were asked to read an informational text (see Appendix) about green buildings and the goals and requirements of the LEED certification process. The participants in the

branding group were also told that they were going to be immersed in an environment that is a part of a LEED certified building. No further information about green buildings, the LEED certification process or the virtual office being part of a LEED certified building was provided to the control group participants.

Experiment Session

After the pre-experiment session, the participants were asked to put back on the head mounted display so that they could be immersed to the experimental virtual environment. In the virtual office, the default lighting setting was minimum amount of available lighting, where the participants were not able to read the passage but could safely go to any location in the room (Figure 5a). Through real-time rendering, three other lighting settings were created: (1) a bright room with all light bulbs on while the blind was closed (Figure 5b); (2) a bright room with the blind open with none of the light bulbs on (Figure 5c); and (3) a bright room with the blind open and all of the light bulbs on (Figure 5d). During the pilot study, different lighting settings were tested to ensure that lighting levels were adequate for occupants in all of the lighting conditions (natural, artificial, or both source of lighting) to read documents in the virtual space.

Figure 5 – Different lighting levels in the room: (a) dark room; (b) bright room with all light bulbs on and the blind closed; (c) bright room with the blind open and all of the light bulbs off; (d) bright room with the blind open and all of the light bulbs on

Participants were told that they had the following options to increase the lighting levels: turn the lights on/off (Figure 6a) and open/close the blind (Figure 6b). The order in which we described these options randomly varied between the participants to eliminate any bias due to any order effect. However, to be able to read the passage, the participants had to increase the lighting levels in the room choosing from one of the three options. In order to eliminate any effects due to the variations in lighting levels in different times of the day, all experiments were conducted on sunny and non-cloudy days between 10 AM and 4 PM Los Angeles time, when there was enough natural light outdoors. For example, a participant might have expected the sky to be dark if we conducted experiments at night or might have expected not have adequate daylight if the experiment was conducted after sunset. The model was also designed to reflect

natural light levels for a sunny Los Angeles day at 12:00 PM so that all of the participants experienced the same level of natural light during the experiment.

(a) (b)
Figure 6 – (a) turn on/off the lights; and (b) open/close the blind

The duration of the experiment was 20 minutes and it included two tasks. First, the participants were asked to read a passage (Figure 7a) and they were told that they would be asked to answer a few questions about the passage at the end of the experiment. Participants' behaviors were observed in terms of whether they chose to open the blind (for natural light) or turn on the artificial lights or both open the blind and turn on the artificial lights in order to have enough light to read the passage. The second task was to throw the scrap paper, which was placed on the desk, in one of the trash storage bins (Figure 7b).

(a) (b)
Figure 7: experimental components: (a) passage on computer monitor; (b) scrap papers on the table

We asked the participants to perform the second task after they were done with the first task. The goal was to observe whether participants would throw the scrap paper in the regular trashcan or in the recycling bin (the recycling bin was clearly labeled) (Figure 8). When participants completed this task, they were asked to remove the head mounted display and thanked for their participation.

Figure 8 – Recycling bin and regular trashcan in the experimental setting

Post-Experiment Session

In the post-experiment session, participants were asked to fill out post-surveys. The post-surveys were composed of six parts: (1) a questionnaire about the passage they read. These questions were to divert participants' attention from the fact that we were observing their pro-environmental behaviors. We did not use this data for the analysis; (2) demographics questionnaire (participants' age, gender, degree objective, and major, etc.) to investigate the influence of these factors on participants' lighting preferences and recycling behaviors and to assess the underlying reasons behind the participants' behaviors indirectly; (3) an IVE interaction questionnaire asking participants what they think about the virtual environment (realism and presence); (4) an environmental value questionnaire, consisted of a 5-point scale, which was used to assess participants' pro-environmental concerns and any potential effects of such concerns on their behavior. Scores on the scale items varied from a low of 1 (strongly disagree) to a high of 5 (strongly agree), with disagree, neutral, and agree as interval points; and (5) an environmental view questionnaire with Yes and No as two possible responses. These questions measured participants' general knowledge about environmental issues, awareness of eco-friendly products and packaging, and awareness of recycling options. These surveys were designed based on questionnaires used by Ishaswini et al. [51] to measure general consumers' environmental concern, knowledge of environmental issues, awareness of eco-friendly products, trust in performance of eco-friendly products and green buying behavior. The survey questions were modified to assess factors more related to building occupants' behaviors rather than consumers' buying behaviors. A sample of these questions are shown in Table 1. Finally, the sixth part of the questionnaire assessed the participants' level of knowledge about sustainability in general by investigating how familiar they were with pro-environment terminologies, such as EPA (Environmental Protection Agency), Energy Star, and WSE (Waste Stream Evaluations). After filling out the post surveys, the participants were thanked and dismissed.

Table 1 - Sample questions about environmental responsibility

Environmental Values	Mean	SD
I am concerned about the current environmental state the world is / in (1 - Strongly disagree, 5-Strongly agree)	3.94	0.81
I always turn the lights off when I leave a room in my house/the / place I work (1 - Strongly disagree, 5-Strongly agree)	4.32	0.69
Environmental Views	Mean	SD
Have you ever sent old or broken household electronic products to be recycled? (1- Yes, 2 - No)	1.41	0.49
Do you purchase correct from the environmental point of view? (1- Yes, 2 - No)	1.58	0.49

Data Analysis

We tested the research hypotheses by performing statistical analysis on the data collected from the participants in the branding and control groups. Chi-squared goodness of fit test (χ^2), *t*-test (*t*), ordinary least square (OLS) linear regression, and multinomial logistic regression were used to analyze the data. The results of chi-squared goodness of fit test was reported with degrees of freedom and sample size in

parentheses, the Pearson chi-square value (χ^2) and the significance level (p), (χ^2 (d.f, N) , p). The results of t -test were reported by t statistic and the significance level (p), (t (d.f), p). Ordinary least square (OLS) linear regression output was reported with un-standardized slope (β), with the t -test (t) and the corresponding significance level (p), (β , $t(N - k - 1)$, p , k equals the number of predictor variables) [52]. The analyses are based on alpha (α equals to 0.05). In order to help interpret the results, p -values (p) are provided below and the null hypotheses (H_0) are rejected when $p \leq \alpha$.

5. RESULTS

The results presented here are based on the 100 participants' ($n=100$) data (50 participants in each group with equal distributions between genders: 25 females and 25 males). Participants were undergraduate students (66%), master students (28%), and PhD students (6%) at the University of Southern California enrolled in different majors including: engineering (28%); psychology (28%); architecture (17%); and other majors (27%) including business, cinematic arts, communication, preventive medicine, etc. The majority of the participants were 18 to 29 years old (71%) and the rest were around 30 to 39 years old (29%).

In order to ensure that the virtual environment was an adequate representation of the physical environment, at the end of the experiments, we asked the participants how realistic the virtual environment was and how easy it was to perform the tasks in the virtual environment. The results showed that the participants rated the realism of the environment to be realistic on average ($M = 3.89$, $SD = 0.42$) based on a five-point Likert scale. 85% of the participants rated the virtual environment to be realistic or very realistic and only 15% of the participants rated it as neutral. In addition, when participants were asked how easy it was to interact with the virtual environment, they rated it to be somewhat easy on average for both the blind ($M = 6.01$, $SD = 0.77$) and lights ($M = 6.09$, $SD = 0.67$) based on a seven-point Likert scale (Table 2). 93% of the participants who opened the blind and 98% of the participants who turned on the artificial lights believed that it was slightly, somewhat or extremely easy to open the blind or turn on the lights in the virtual environment and the remaining participants rated it to be neutral.

Table 2 - IVE interaction questions

Questions	Mean	SD
How realistic was the virtual environment? (1 Not realistic, 5 Very realistic)	3.89	0.42
How easy or difficult was it to open the blind in the virtual office? (1 Extremely difficult, 7 Extremely easy)	6.01	0.77
How easy or difficult was it to turn on the lights in the virtual office? (1 Extremely difficult, 7 Extremely easy)	6.09	0.67

For investigating the influence of LEED branding on participants' lighting preferences and recycling behaviors, we observed the participants' choice of natural light vs. artificial light in order to increase the lighting levels in the room. It is important to note that in our analysis, we assumed the behavior is not environmentally conscience if the participant chose to use a combination of natural and artificial light at the same time. Therefore, herein after, when we analyze the data for artificial light use, we include the choice of artificial light even if the blinds were open at the same time (Table 3).

Table 3 - Branding group vs. control group (number of the participants in terms of choice of natural light vs. artificial light)

Group	Artificial light	Artificial + natural light	Natural light
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Branding	10	15	25
Control	20	21	9

The results showed that, in the branding group, the percentage of participants who chose artificial lights and chose both natural and artificial lights (50%) were the same as the percentage of the participants who solely chose the natural light (50%). However, in the control group, the percentage of participants who turned on the artificial lights or both opened the blinds and turned on the artificial lights (82%) were significantly more than the participants that just opened the blinds to increase the lighting levels in the room (18%). Statistical analysis, using a chi-squared goodness of fit test, showed that the percentage of participants who chose just natural light in the branding group was significantly more than the percentage of the participants who made this choice in the control group ($\chi^2(1, N = 100) = 11.408, p = 0.001 < 0.05$). Therefore, the result was significant at $p < 0.05$, accepting Hypothesis 1, which suggested that the participants in branding group would choose natural light to increase the lighting levels significantly more than the participants in the control group (conformity). Table 4 shows more details of the analysis.

Table 4 – Branding group vs. control group (χ^2 analysis - natural vs. artificial light)

	Natural light	Artificial light	Total
Branding group	25 (17) $\chi^2 = [3.76]$	25 (33) $\chi^2 = [1.94]$	50
Control group	9 (17) $\chi^2 = [3.76]$	41 (33) $\chi^2 = [1.94]$	50
Total	34	66	100

In addition to the lighting preference, we investigated the impact of LEED branding on participants' recycling behavior. Participants' choices of use of recycling bin vs. regular trashcan for placing the scrap paper were observed. The results showed that the percentage of the participants who used recycling bin in the branding group (92%) was more than the percentage of the participants who used recycling bin in the control group (76%). The results of the statistical analysis, using a chi-squared goodness of fit test, showed that the percentage of the participants who chose recycling bin in the branding group was significantly more than the percentage of the participants who did the same in the control group ($\chi^2(1, N = 100) = 4.762, p = 0.029 < 0.05$). Therefore, the result was significant at $p < 0.05$, accepting Hypothesis 2, which suggested that the participants in the branding group would choose recycling bin to place the scrap paper significantly more than the participants in the control group (conformity). Table 5 shows more details of the analysis.

Table 5 – Branding group vs. control group (χ^2 analysis (Recyclable trashcan vs. regular trashcan))

	Recycling Bin	Regular trashcan	Total
Branding group	46 (42) $\chi^2 = [0.38]$	4 (8) $\chi^2 = [2]$	50
Control group	38 (42) $\chi^2 = [0.38]$	12 (8) $\chi^2 = [2]$	50
Total	84	16	100

We also examined the effects of the participants' environmental values and views, and demography characteristics on their lighting preference and recycling behaviors. We first checked the collected data to make sure that participants were distributed evenly in the control and branding groups in terms of gender, age, degree objectives (e.g., undergraduate, master, PhD), major (e.g., engineering psychology, architecture, etc.), and environmental values and views. The statistical analysis confirmed that there was no significant difference between the two experimental groups in terms of aforementioned factors. Based on data collected from the personality test, and demographic characteristic surveys using linear regression, the results showed that there were no significant effects between participants' demographic

characteristics and their lighting preferences and recycling behaviors in both the branding and control groups.

Linking the data collected from the environmental values and views surveys to the experiment results by using simple linear and logistic regression analyses with environmental values predicting each dependent variable (DV), we found that among participants in the total sample, environmental values influenced their lighting preferences ($\beta = 0.015$, $t(98) = 2.160$, $p = 0.033 < .05$) and recycling behaviors ($\beta = 0.012$, $t(98) = 2.175$, $p = 0.032$). In addition, significant effects were observed between participants' environmental views and their lighting preferences ($\beta = 0.059$, $t(98) = 2.272$, $p = 0.025 < 0.05$) and recycling behaviors ($\beta = 0.061$, $t(98) = 3.075$, $P = 0.003 < .05$). Participants with more favorable environmental values and views were more likely to open the blinds to increase the lighting levels in the room or place the scrap paper in the recycling bin. Knowing that participants' environmental values and views influenced their lighting preferences and recycling behaviors, we investigated if these values and views would influence the effects of branding on participants' lighting preferences and recycling behaviors. To do this, we ran separate regression analyses using environmental values and views as predictors to predict participants' lighting preferences and recycling behaviors in the branding and control groups, respectively. The results showed that there were significant effects between participants' environmental values and their lighting preferences ($\beta = 0.26$, $t(98) = 2.481$, $p = 0.017$) in the branding group. Predicting our key DVs from participants' environmental views (rather than environmental values), the results showed significant effects between participants' environmental views and their lighting preferences ($\beta = 0.095$, $t(98) = 2.676$, $p = 0.010 < 0.05$) and the recycling behaviors ($\beta = 0.055$, $t(98) = 2.898$, $p = 0.006 < 0.05$) in the branding group. On the other hand, no significant effects were found between participants' environmental values and their lighting preferences ($\beta = 0.002$, $t(98) = 0.258$, $p = 0.798 > 0.05$) in the control group. The same results were found when examining the influence of the participants' environmental views on their lighting preferences ($\beta = -0.008$, $t(98) = -0.229$, $p = 0.820 > 0.05$) and recycling behaviors ($\beta = 0.058$, $t(98) = 1.618$, $p = 0.113 > 0.05$) in the control group. These results showed that in the branding group, participants with higher environmental values and views were more likely to open the blind and participants with higher environmental views were more likely to recycle the paper but there were not any significant effects between environmental values and views and lighting preferences and recycling behaviors in the control group confirming that participants' environmental values and views influence the effects of branding (Hypothesis 3). These findings might also suggest that LEED branding made participants' environmental values and views salient to them, leading them to act more pro-environmentally (conformity), while we cannot see these effects of environmentalism on behaviors of the participants in the control group.

At the end of the experiment, we asked the participants in the branding group if they thought being in a virtual LEED certified building affected their choices. Forty-three participants from the branding group answered this question. The results showed that 18% of the participants in the branding group believed that being in a LEED certified building affected their behaviors in terms of opening the blinds or turning on/off the lights. In addition, 44% of the participants in the branding group said that being in a LEED certified building affected their behaviors in terms of recycling the scrap paper. A chi-squared goodness of fit test showed that there was no significant difference between participants' choices in terms of opening the blinds or turning on the artificial lights to increase the lighting levels of the room ($\chi^2(1, N = 43) = 1.010$, $p = 0.315 > 0.05$) and participants' acts of recycling ($\chi^2(1, N = 43) = 3.491$, $P = 0.062 > 0.05$) between those who believed being in a LEED certified building affected their behavior and those who did not.

We also investigated if participants' familiarity with pro-environment terminologies, such as EPA (Environmental Protection Agency), Energy Star, and WSE (Waste Stream Evaluations) had any influence on participants' lighting preferences and recycling behaviors. Linear regression analysis results

revealed that there were significant effects between how familiar participants were with different environmental related terminologies and their choices for natural vs. artificial light to increase the lighting levels of the room ($\beta = 0.089$, $t(98) = 2.176$, $p = 0.032 < 0.05$) and recycling bin vs. regular trashcan to place the scrap paper ($\beta = 0.085$, $t(98) = 2.726$, $p = 0.008 < 0.05$). These results showed that the participants who had more knowledge about pro-environment terminologies were more prone to use natural light and recycle the paper. These results suggest that the level of building occupants' knowledge surrounding environmental issues and their solutions have positive correlations with their electricity and waste reduction activities.

6. DISCUSSION AND CONCLUSIONS

Although in green buildings, technological improvements and sustainable design have been adopted, they are only successful when implemented correctly by the occupants of a LEED certified building, therefore, there is a need to motivate occupants toward adoption of more sustainable behavior. However, the review of the previous studies shows that there is no consensus among scholars whether working in green buildings motivates occupants' pro-environmental behavior (conformity) or wasteful behavior (compensation). In this study, we specifically investigated the influence of LEED branding on building occupants' pro-environmental behavior by examining two specific behaviors in an experimental setting: natural vs. artificial lighting preferences and recycling behaviors. The results showed that LEED branding promotes occupants' pro-environmental behaviors. The participants chose natural light significantly more than the artificial light in the branding group compared to the control group, suggesting that LEED branding influences occupants' lighting preferences positively, potentially motivating electricity consumption reduction. The results also revealed that participants in the branding group chose recycling bin significantly more than regular trashcan in comparison with the participants in the control group; this suggests that LEED branding influences building occupants' recycling behaviors positively, potentially motivating behavior that is towards waste reduction. Therefore, we can conclude that branding a building as a LEED certified building could result in conformity and not compensation. These results suggest that it is possible to motivate LEED certified building occupants toward adoption of more pro-environmental behaviors by letting occupants know that the building is LEED certified and provide them with knowledge about LEED certification, its functional attributes and emotional benefits.

We also explored factors, such as individuals' demographic characteristics, and environmental values and views that could have influenced participants' behaviors indirectly. Investigating how individuals' demographic characteristics (e.g., age, gender, and education) is related to their behaviors, we found no relationship between participants' demographic characteristics and their pro-environmental behaviors. On the other hand, the results showed that there was strong relationship between participants' environmental values and views and the influence of LEED branding on their choice of natural vs. artificial light and recycling bin vs. regular trashcan. The participants with higher environmental values and views were more likely to adopt pro-environmental behaviors under the influence of LEED branding. Our results also suggested that increasing building occupants' knowledge about environmental issues might improve their pro-environmental behaviors.

7. LIMITATIONS AND FUTURE RESEARCH

LEED is one of the most suitable branding labels we could have used for this study as LEED certified buildings are commonly known to be more sustainable. However, the notion that the LEED certified buildings are always true examples of green buildings is not agreed by all [53]. This fact can be considered as a limitation of LEED as well as a limitation of this study. Although we were able to provide sample group of participants large enough (with 85% power) to produce statistically significant results, the confidence in the results would be increased if we could increase the power by increasing the number of the participants. Recruiting people to participate in experiments is one of the limitations of the human subject studies like the one presented here. Additionally, this experiment used a novel approach for data

collection and observing participants' interactions with the designed environment, which provided us with the ability to focus on the variable of interest (i.e., influence of branding), and eliminate the influence of the potential confounding variables such as time of the day and various sky conditions. Although that the participants rated the IVE to be realistic and we ensured to design the IVE interactions to be as similar to a physical office as possible, there exists a minor set of factors that could have influenced the interactions of the participants with the virtual space. For example, in order to open/close the blinds in a physical office, users would have to pull down on the strings. However, in the virtual environment, a user had to open or close the blinds by standing in front of the window and clicking a button on the controller. Therefore, there might be differences in the effort needed for the blind operation in the physical and virtual environments which could be improved with higher quality devices (e.g., tracking gloves, tracking sensors, and etc.) to improve participants' sense of presence within a virtual environment. According to participants' responses on the realism of the IVE as well as our experience from previous studies where we used IVE for evaluating design factors in an office environment, we believe the limitations of IVE were not significant enough to have an influence on the participants' interactions with the LEED office space.

The assigned task in measuring the influence of LEED branding on the participants' lighting preferences was to read over a passage, where the experiment was designed in a way that there was not enough lighting available for the participants to read over the passage and they had to increase the lighting levels either by opening the blind or turning on the artificial lights. This task was designed in a way that the participants had to indirectly make an energy-behavior decision without the experimenter specifically informing them. However, in examining the influence of the LEED branding on the environmental behaviors, the assigned task included placing scrap paper in one of the storage bins, which was more directly associated with the act of recycling. Therefore, there could possibly exist an "experimenter demand effect" for the second task, where the participants were provided with a cue that constitutes an appropriate behavior. For example, participants may have chosen to put the scrap paper in the recycling bin because they knew the experimenter was watching and they thought that was the "appropriate" response or what the experimenter wanted them to do. To avoid this issue, the experiment could have included various tasks that could help us investigate the influence of the LEED branding on the environmental behavior more indirectly.

Lastly, in this study, the participants were students at the University of Southern California who were highly educated and mostly around 18-29 years old. Therefore, the results might not represent the entire population. One of our future planned works is conducting experiments with larger sample sizes with more variety in participants' demographic characteristics to fully investigate the correlation of these factors with LEED branding and be able to generalize the results to larger population. In this study, we investigated the influence of LEED branding on building occupants' pro-environmental behaviors with two examples: lighting preferences and recycling behaviors, however, investigating the influence of LEED branding on other pro-environmental behaviors such as water management is in our future work. In addition, this study was not a longitudinal study and we did not investigate the long-term influence of LEED branding on behaviors. The results of this study show that LEED branding influence lighting preferences and recycling behaviors however investigating the long-term influence of the LEED branding is among our future planned work. Lastly, in this study a single occupancy office space was used, however people's behavior might change in the presence of others [54], therefore, we will examine the influence of LEED branding in other architectural settings such as multi-occupancy or open-plan offices in our future work.

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APPENDIX

Green buildings and LEED certification

Over the past century, human activities have released large amounts of carbon dioxide and other greenhouse gases into the atmosphere. Greenhouse gases act like a blanket around the Earth, trapping energy in the atmosphere and causing it to warm up. This phenomenon is called the greenhouse effect and is natural and necessary to support life on Earth. However, the buildup of greenhouse gases can change Earth's climate and result in dangerous effects to human health and welfare and to ecosystems [55]. It is estimated that at present, buildings contribute as much as one third of total global greenhouse gas emissions, primarily through the use of fossil fuels during their operational phase. Therefore, buildings have great impact on the natural environment, human health, and the economy. One solution is adopting green building strategies, by which we can maximize both economic and environmental performance of buildings. Green building design is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from design to construction, operation, maintenance, renovation and deconstruction [56].

Green buildings are designed to reduce the overall impact of the built environment on human health and natural environment by:

- Efficiently using energy, water, and other resources;
- Protecting occupant health and improving employee productivity;
- Reducing waste, pollution and environmental degradation.

For example, green buildings incorporate sustainable materials (e.g., reused, recycled-content, or made from renewable resources) and dedicate places for collection of recyclable materials in order to reduce the need for extracting, refining, and processing raw materials and reduce energy consumption and greenhouse gas emissions. Green buildings create healthy indoor environments by improving indoor air quality and reducing exposure levels for indoor pollutants (e.g., reduced product emissions). Green buildings also decrease energy consumption by taking advantage of natural lighting and ventilation and using efficient appliances. In addition, green buildings feature landscaping that reduces water usage (e.g., by using native plants that survive without extra watering).

To recognize how green a building is, LEED or Leadership in Energy & Environmental Design, a green certification program, is implemented in the United States. LEED provides building owners and operators with a framework for identifying and implementing practical and measurable green building designs, construction, operations, and maintenance solutions. If a building project is considered as LEED certified, it means that the building is truly "green" and has achieved its environmental goals. There are four levels of certification, depending on the number of points a project earns during certification: LEED certification, Silver LEED certification, Gold LEED certification and Platinum LEED certification (the highest degree of certification). There are thirty LEED certified, sixty Silver LEED certified, fifty five Gold LEED certified, and five Platinum certified buildings in Los Angeles.

The building in our study is Gold LEED certified. Offices are decorated with reused furniture, which is made from certified wood (wood products that come from responsibly managed forests). The walls are painted with organic chemicals. The floors are carpeted with LEED labeled materials (materials that meet the LEED certification requirements). The rooms have dedicated bins to separate the recyclable trashes from non-recyclable ones. The building also takes advantage of LED lighting and automated control systems, which improve energy efficiency and may result in up to 30% electricity savings.

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