Illuminating Illumination:

Understanding the Influence of Lighting on Socially Conscious Behaviors

Sina Esteky [a][1], David Wooten [b], and Maarten Bos [c]

[a] Farmer School of Business, Miami University, Oxford, OH 45056, United States

[b] SC Johnson College of Business, Cornell University, Ithaca, NY 14853, United States

[c] Disney Research, Pittsburgh, PA 15213, United States

[1] Corresponding author. E-mail: estekys@miamioh.edu

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ABSTRACT

A growing body of literature shows that illumination can affect human behavior. Some research suggests that exposure to bright (versus dim) light facilitates socially conscious behaviors; other studies record the opposite. With the current work, we explore how and when illumination, specifically the intensity of light, affects such behaviors. Using ambient lighting, we demonstrate that illumination generally increases socially conscious behaviors such as conformity, helpfulness, fairness, and perspective-taking. In other words, participants exposed to bright lighting are more likely to act upon others' opinions, needs, rights, and views. We also provide process evidence suggesting that public self-consciousness mediates the effect of illumination on such behaviors. We find that the effect reverses in social contexts involving outgroups. Supported by our findings, we develop a unified explanation for the psychological consequences of a ubiquitous, yet often subtle environmental factor - illumination.

Light predates humankind's existence by billions of years. Our early ancestors were at the mercy of Mother Nature and the daily cycle of light and dark. Over the course of millennia, we learned to harness light and use it to our advantage. Now, we live in an era in which illumination engulfs us day and night and we take it for granted. Still, we know very little about its impact on our choices and behaviors. Recent studies suggest that illumination, like many other environmental factors, may have a subtle yet significant impact on individuals' judgments and decisions because it is often beyond conscious awareness (Dijksterhuis et al. 2005; Turley & Milliman, 2000; Wansink & Chandon, 2014). Even when they do notice it, people typically cannot block out, control, or avoid lighting conditions in their surroundings. Mehrabian (1976) argued that lighting is a chief factor in the environment's impact on human behavior. Furthermore, researchers in environmental, social, and consumer psychology have described lighting as one of the main atmospheric factors influencing human behavior (Bitner, 1992; Belk, 1975; Kotler, 1973; Quartier, Christiaans, & Van Cleempoel, 2009; Greenland & McGoldrick, 1994; O'Neill & Jasper, 1992; Spence et al. 2014; Turley & Milliman, 2000).

Despite the common belief that lighting conditions in physical environments matter, illumination's effect on human behavior is not clear and there is contradicting evidence in the literature regarding its influence on choices and actions in social settings. The connection between lighting and social awareness is deeply ingrained in figurative language. Expressions such as "putting a spotlight on somebody", "being in the limelight" or "stealing the spotlight" are often used to metaphorically describe the extent to which people attend to or are attended by others. This suggests that social visibility may be enhanced as a result of better physical visibility in bright lighting conditions, which raises the question: Are people more considerate of the social consequences of their actions and behavior under bright lighting?

On the other hand, dim lighting conditions may lead to uncertainty about the environment, and necessitate increased trust and reliance on others. If so, one may argue that people are in fact, more considerate of the social consequences of their actions and behaviors under dim lighting. Empirical research in favor of both predictions can be found in the literature.

Thus far, lighting's effects on behaviors in social situations has not been examined as a single phenomenon and no studies to date have demonstrated a unifying theory that explains the role of lighting in such behaviors. In this article, we reconcile previous findings and explore the psychological and behavioral consequences of lighting, specifically focusing on its effects on socially conscious behaviors, which we define as actions occurring in social contexts that are primarily driven by social cues rather than internal beliefs, dispositions, and motives. From a social psychology perspective, these are particularly important behavioral outcomes because they are grounded in the assumption that a decision maker is a social object whose actions within a wide range of domains can be influenced by others. Therefore, explaining such influences with an overarching principle can further enrich our understanding of the multifaceted mechanisms driving social behaviors Building on this premise, we test how lighting affects people's perception of themselves in relation to others and how this focus on self (versus others) affects a range of seemingly unrelated actions that can all be categorized as socially conscious behaviors (such as evaluating a drink, making a donation, helping a stranger, literally taking someone's perspective). The potential impact of lighting on behavior in social contexts raises many questions. For instance, could subtle changes in lighting levels in a room alter individuals' social awareness? Could bright lighting conditions literally and figuratively put one's social environment under the spotlight and cause one to act in more (or less) socially conscious ways? If so, how and when?

We answer these questions in this paper. We show that bright (vs. dim) lighting encourages social consciousness in a variety of behaviors. Delving deeper into the process, we show that brightness induces such behaviors via increasing a sense of public self-consciousness. Furthermore, the behavioral effect of lighting depends on the social context. In the remainder of the paper, we build our conceptual framework and hypotheses, describe the experiments, and finally present conclusions and ideas for future studies.

THEORETICAL BACKGROUND AND HYPOTHESES

The role of lighting on several aspects of human behavior is not clear, and the literature contains mixed results (Baron, Rea, & Daniels, 1992). This is particularly true in the domain of social psychology. Dim lighting has been shown to promote antisocial behavior (Zhong, Bohns, & Gino, 2010). Zimbardo (1969) argued that dimly lighted environments may induce a state of deindividuation. Page and Moss (1976) suggested that lighting may have important consequences for social behaviors and proposed that dim lighting acts as a social disinhibitor. Dim lighting has been shown to reduce inhibition by increasing anonymity, leading to increased self-interested behavior and aggression (Hirsh, Galinsky, & Zhong, 2011; Prentice-Dunn & Rogers, 1980). It has also been suggested that exposure to dimmer lighting in the evening/night promotes general behavioral disinhibition (Kasof, 2002).

Contrary to these findings, several studies suggest opposite effects of lighting on social behavior. Several studies suggest that dim lighting in fact promotes prosocial rather than antisocial behavior (e.g., Steidle, Werth, & Hanke, 2011; Steidle, Hanke, & Werth, 2013; Werth, Steidle, & Hanke, 2012; Bohns, Gino, & Zhong, 2010). Steidle and colleagues (2013) argued

that dimness increases social distance, and this leads to compensatory reactions by individuals to reduce the distance by engaging in collaboration and helping others. Others (Gergen, Gergen, & Barton, 1973; Miwa & Hanyu, 2006) also demonstrate that people seek more social closeness in dimly lit environments. Several of these studies are built on the assumption that experiencing dim environments increases people's inclination to affiliate with others (Darley & Aronson, 1966).

We propose three possible sources of discrepancy in the literature: 1) A difference between ambient illumination and targeted illumination. In this paper we focus on ambient illumination, which is lighting that is evenly dispersed in a space, hence increasing awareness of social environment; 2) A difference between illumination and lighting color (dim vs. warm lighting, bright vs. cool lighting) which has often been used interchangeably in the literature. To deal with this, we focus solely on the intensity of light - measured in lux; 3) Unidentified moderators of the psychological effects of illumination, for instance, social context. We argue that brighter lighting emphasizes the social context, and that this context drives behavior.

Emphasizing the third point, we hypothesize that illumination increases physical visibility and bolsters social visibility, which leads to higher public self-consciousness, and as a result, behaving in a more socially conscious manner. This, in effect, juxtaposes findings suggesting that dim lighting leads to more pro-social behavior (e.g., Zhong, Bohns, & Gino (2010); Steidle and colleagues, 2011, 2013), and proposes that bright lighting may lead to more pro-social or more anti-social behavior depending on the social context, for instance whether one is surrounded by friends or strangers. In other words, in this study we qualify two opposing streams of research on the social influence of lighting on human behavior, and present a framework that is compatible with the previous findings. Based on our framework, we expect

that the social context would interact with heightened awareness of one's social context in

brightly lit environments, hence leading them to be more self-focused or more other-focused. We

discuss the social context in terms of reference group influences (Tajfel, 1982; Marques,

Abrams, & Paez, 1998). In an in-group context, this may lead to acting upon social (versus self-

centered) motives; while in an out-group situation the opposite may occur. This may help explain

the seeming inconsistency in prior findings regarding lighting's influence on social behavior. We

test the following hypotheses using an array of behaviors (conformity, fairness, charitable

donations, volunteering, and perspective-taking) to test for the robustness of our findings. First,

we propose that individuals display more socially conscious behavior under bright lighting.

Furthermore, we posit that public self-consciousness mediates the effect of illumination on

socially conscious behavior. Finally, we hypothesize that individuals interacting with ingroup

(versus outgroups) under bright illumination are more likely to display self-regarding (vs. other-

regarding) preferences.

Figure 1 – Conceptual Framework
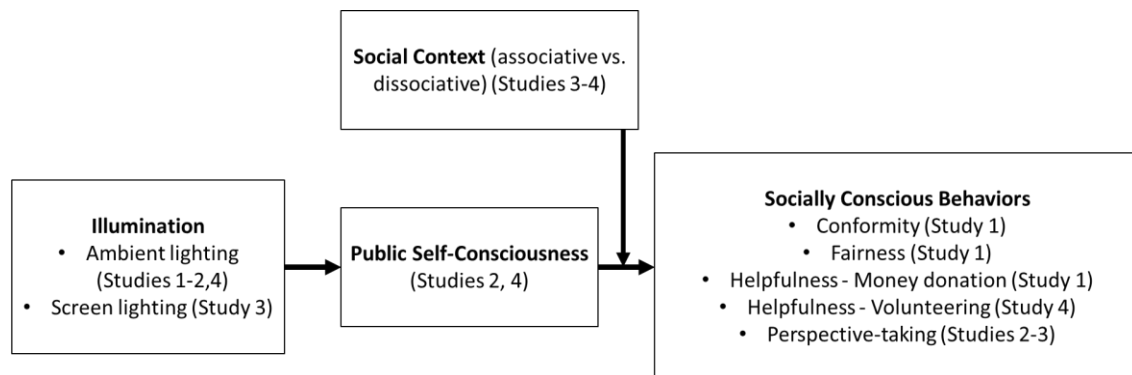
OVERVIEW OF STUDIES

Four studies provide empirical evidence for the role of illumination on socially conscious behaviors. In the first study, we demonstrate that lighting can affect a range of behaviors with social consequences. More specifically, we show that participants in a brightly-lit room (vs. dimly-lit room) conform more to others' opinions in a beverage test, donate more to a charity campaign and are more sensitive to fairness in an ultimatum game. It is important to note that the dependent variables investigated in this experiment are different in more than one way. However, the objective of this study and the next ones is to examine the robustness of the proposed effect across a wide range of behaviors that fit our definition of socially conscious behaviors, even though they may be disconnected in other aspects. In the second study, we show that public self-consciousness mediates the relationship between illumination and socially conscious behavior, in this case, perspective-taking. In the third study, we show that lighting's effect reverses in the presence of outgroups, where heightened social consciousness no longer necessitates social desirability, but rather fosters self-centered behavior. The fourth study replicates our findings using helpfulness towards others, and finds evidence for the proposed moderated mediation process.

STUDY ONE

Does illumination affect choice dilemmas in social situations? We theorize that individuals in a brightly lit (versus dimly lit) setting will be more socially conscious; hence, more likely to make decisions based on others' opinions, rights, and needs. We study three corresponding behaviors with crucial implications for social psychology: conformity, fairness, and helpfulness. Regarding conformity, we argue that people in a bright environment will be more likely to choose a product based on reviews by others as opposed to their personal sensory

experience. This should lead participants in a bright room to be more likely to choose a highly-rated yet unsavory drink over a tasty yet unpopular drink and be willing to pay more for it compared to participants in a dimly lit room. Regarding fairness, we hypothesize that under bright (versus dim) lighting conditions individuals will be fairer and more sensitive towards fairness. Hence, participants playing the ultimatum game in a brightly lit room will offer a fairer share of cash to others. On the other hand, under bright (versus dim) illumination, players will also feel more socially conscious, thus, more sensitive towards being treated fairly by others, and as a result more likely to reject unfair offers they receive. Therefore, we expect to observe more rejections in the bright environment controlling for the amount offered by proposers. Lastly, regarding helpfulness, we hypothesize that participants in a brightly lit room will be more considerate of others' needs; therefore, they will donate more money for charitable purposes than participants in a dimly lit room.

Method

One hundred-two students with no reported food allergies (45 females and 57 males) at the University of Michigan participated in this study for a maximum payment of $22. Participants received $2 for showing up, $10 for completing several tasks, and an opportunity to earn up to $10 extra by playing the ultimatum game. Participants were randomly assigned to complete three tasks in a bright, average, or dim auditorium, with illumination set at 900, 500 or 100 lux, respectively. These illumination levels were set according to the recommended illuminance levels for performance of visual tasks involving high, medium and low dexterity, respectively (GSA, 2003). Despite this, a manipulation check was performed on the lighting conditions. A university auditorium was chosen as the venue for this experiment as students are accustomed to experiencing a wide range of lighting levels in such spaces and would not be

suspicious of any irregular lighting conditions. Participants were not informed that the

experimenters were studying illumination and were told instead that they would be completing

various unrelated consumer decision tasks. We used two realistic scenarios involving a product

prelaunch testing and a charity donation to measure subjects' conformity and helpfulness,

respectively. We used the ultimatum game (Guth, Schmittberger, & Schwarze, 1982) to evaluate

subjects' fairness towards others and their sensitivity to being treated fairly by others. The three

tasks were completed in the following order: Taste test (conformity), ultimatum game (fairness),

charity donation (helpfulness). It is important to note that we cannot rule out the possibility of an

order effect, although we have no reason to rule it in either.

Measures

   Conformity. We tested conformity using a beverage taste test. Participants were asked to

taste two new beverages being launched, choose the one they preferred and indicate how much

they were willing to pay for a 10-ounce bottle of it. The options included a tasty drink with bad

reviews and an unsavory drink with good reviews. The tasty drink was a 3-ounce cup of organic

apple juice fictitiously described as having received an average rating of 2 out of 5 stars by other

participants. The unpleasant drink was a similar cup of apple juice mixed with a bit of salt,

labeled with an average rating of 4 out of 5 stars. Both drinks were pretested for pleasantness. A

separate sample of 31 participants rated the two drinks for their tastiness on a 1-7-point scale.

This pretest indicated that the organic apple juice was judged as being tastier ($M = 4.74$, SD =

2.12) than the slightly salty drink ($M = 3.61$, SD = 1.60; $t(30) = 2.91$, $p < .01$, $d = .601$). We used

product preference and willingness to pay to measure conformity.

   Fairness. In the second part of the experiment, we used the ultimatum game to study

fairness. In this often-used game two players interact to decide how to divide a sum of money.

The first player (proposing player) proposes how to divide the sum between the two players, and the second player (recipient player) can either accept or reject this proposal. If the recipient rejects, neither player receives anything. If the recipient accepts, the money is split according to the proposal. The game is played only once between a pair of players so that reciprocation is not an issue. In the current study, the proposing player was given $10 in cash, to divide between the players. We randomly assigned and matched proposing and recipient players for the first round, and subsequently switched roles and matched players again so that all participants were given a chance to act as the proposer and recipient. We used the amount offered (US dollars) by proposing players as a measure of fairness towards others and rejection of offers by recipient players as a measure of sensitivity towards fairness.

Helpfulness. In the third part of the experiment we used monetary donations as a measure of helpfulness (e.g., Vohs, Mead, & Goode, 2006; Twenge et al. 2007). Upon arrival to the auditorium, to make sure participants had cash, they were given $2 in quarters in exchange for their participation. After they completed all other parts of the study participants were told that the experiment was complete and were given a false debriefing and dismissed. With this step, we ensured that participants did not connect the donation opportunity to the experiment. As the experimenter exited the room, he mentioned that the lab was taking donations for the Pediatric Cancer Foundation and that there was a box by the door if the participant wished to donate. Participants were provided with small envelopes to use for donations. Unbeknownst to them, the envelopes were ID'ed, to enable tracking of each participant's donation. The amount of money donated (US dollars) was used as a measure of helpfulness.

Results and Discussion

Conformity. A chi-square test showed a significant effect of lighting on conformity, with bright lighting leading to more conformity than less intense lighting conditions (29% in bright condition vs. 9% in average light condition; 12% in dim condition), χ^2 (2, N = 102) = 6.071, $p <$ .05, $\varphi = .24$ Participants in a bright room were almost three times as likely to choose a more highly-rated, yet less tasty drink compared to those in other conditions. Another chi-square test was conducted to compare conformity in bright versus dim conditions in particular, χ^2 (1, N = 68) = 3.238, $p = .071$, $\varphi = .21$. Participants in a bright room were more likely to conform (i.e., choose the drink based on reviews) compared to those in a dim room. These results are in line with those of Steidle and Werth (2013) suggesting that dim lighting facilitates non-conforming ways of thinking. Lighting did not influence willingness to pay for the drink ($F<1$). These results suggest that lighting may have an impact on conformity in terms of product preference, but that this increased attractiveness of the "popular" option does not necessarily lead to greater WTP. We may speculate that given the incongruence between the sensory (vs. social) judgment of the product, illumination may have been effective enough to shift behavior with no financial consequences (i.e., preference) but not WTP – which we assume may be more resistant to peer influences.

Fairness. With an ANCOVA using the amount of money offered in the ultimatum game as a covariate, we found support for the hypothesized effect of illumination on sensitivity towards fairness. Participants in a bright environment were more likely to reject unfair offers compared to participants in other conditions (35% in bright condition vs. 17% in averagely lit condition and 14% in dim condition) when controlling for the amount offered, F(2, 101) = 5.413, $p < .01$, $\omega^2 = 0.081$. However, unsupportive of our hypothesis regarding being fairer, lighting did not affect the amount offered by proposing players, F(2,101) = 1.397, $p = .25$, $\omega^2 = 0.027$. In

other words, illumination influenced participants' sensitivity towards being treated fairly -

resulting in higher rejection of unfair offers-, but not necessarily their own fairness towards

others. This suggests that the social consequences of illumination may be more complex than a

"pro-social" vs. "anti-social" dichotomy. Specifically, brightness leading to more sensitivity

towards the outcomes of others' decisions, but not ones' own seems to suggest that lighting may

increase others-oriented behavior (what we label "socially conscious behavior", e.g., sensitivity

towards being treated fairly by others), but not necessarily pro-social behavior (e.g., treating

others fairly). Please note, when we refer to socially conscious behavior, our definition is more

closely related to awareness of and attention to social context, rather than concern or inclination

towards it. In study 2 we will explore other forms of behavior that may be considered socially

conscious and others-oriented, but not pro-social and further delve into the underlying processes.

　　Helpfulness. A one-way ANOVA showed that the results for helpfulness followed a

similar pattern to conformity and fairness. We found a significant main effect of bright lighting

leading to more charitable donations, $F(2, 101) = 4.921$, $p < .01$, $\omega^2 = 0.09$. As predicted,

participants in a bright room donated more ($M_{bright} = \$1.39$, SD =) compared to participants in

the other conditions ($M_{average} = \$0.85$, and $M_{dim} = \$0.72$). An independent-samples t-test was

conducted to compare helpfulness in bright versus dim conditions. There was a significant

difference in donations between these two conditions, with participants in the bright condition

donating more than their counterparts in the dim condition, $t(66) = 2.836$, $p < .01$, $d = .688$.

Taken together, study 1 supports the thesis that illumination can affect a range of behaviors in a

similar way. We demonstrate that when exposed to bright lighting, individuals are more likely to

act in a socially conscious manner. We found that participants in bright lighting conditions were

more likely to make decisions that were counter to their own sensory experience, and in one

case, their financial interests. Specifically, they were more likely to take others' opinions (beverage test), fairness (ultimatum game) and needs (donation) into account when making a decision. As discussed earlier, this is not necessarily the same as being more pro-social, but rather demonstrate heightened social consciousness. Interestingly, these findings suggest that the social influence of lighting on behavior is driven primarily by brightness rather than dimness. In other words, while being in a brightly lit room (compared to an averagely lit room) resulted in significantly more socially conscious behavior, being in a dimly lit room did not differ significantly from being in an averagely lit room. The non-linear pattern emerging from the results suggest that putting a spotlight on surrounding environment and people (visually and conceptually) facilitates socially conscious decision making more than being under dim lighting can disinhibit such behaviors. It is important to note, given the nature of the tasks, we were not able to counterbalance the tasks, and acknowledge that an order effect is possible, even though we do not have any reason to suspect so. To address this possibility, we replicate the results of our last measure, helpfulness, in study 4. Study 2 also replicates these results with a different social dilemma involving perspective-taking. We also dig deeper into illumination's role to explain why this effect occurs.

STUDY TWO

Study 1 confirmed that lighting influences socially conscious behaviors in a consistent manner. However, it is still unclear how this phenomenon occurs. In this experiment, we look at the influence of lighting on a different behavior: perspective-taking. We predict that participants in a bright (vs. dim) environment, would be more socially conscious, thus more likely to spontaneously adopt another person's perspective (Underwood & Moore, 1982). We also test our

assumption that people pay more attention to their surroundings as a result of increased visual saliency under bright lighting conditions. To do this, we investigate the effect of illumination on spatial recall. We hypothesize that subjects in a bright (vs. dim) room are more aware of their environment; therefore, they would demonstrate better spatial recall. In this study, we also examine the mediating role of public self-consciousness, which is defined as the tendency to be aware of oneself as part of a social context (Fenigstein, Scheier, & Buss, 1975). Other researchers have hinted at the role of self-awareness on human behavior in bright environments. For instance, Kasof (2002) investigated the interaction of illumination and dieting and proposed that heightened self-awareness may mediate the effect of lighting on eating behavior but did not test this hypothesis. We argue that the underlying mechanism driving the behavioral effect of lighting is as follows: Bright light will increase visual saliency of the environment and public self-consciousness. This, in turn, will promote socially conscious behaviors, in this case, perspective-taking.

Alternatively, one may argue that individuals become less concerned with the social consequences of their actions under dim lighting because darkness may metaphorically induce a sense of possessing power (see Banerjee et al. 2012). Another line of reasoning may suggest that this effect is due to increased motivation to act ethically under bright lighting (see Zhong, Bohns, & Gino, 2010). In other words, individuals may be more socially conscious in bright light because brightness is metaphorically associated with being ethical. In this study we examine these alternative explanations.

Method

Sixty-four students at the University of Michigan (43 females and 21 males) were paid $15 to participate in the study. Participants were randomly assigned to complete several tasks in

a brightly lit (800 lux) or dimly lit (200 lux) room. Participants were told that the experimenters were interested in studying cognitive performance and physical dexterity (i.e., performing various manual tasks). Participants' age, gender, and handedness were recorded at this point. To assess perspective-taking we used a procedure created by Hass (1984, also see Galinsky, Magee, Inesi, & Gruenfeld, 2006) in which participants were asked to draw an "E" on their foreheads. One way to complete this task is to draw an "E" as though one is reading it oneself, which leads to a backward "E" from the perspective of another person. This indicates a self-oriented approach. The other way to respond to the task is to draw the "E" as though another person is reading it, which leads to the production of an "E" that is backward to oneself. This indicates an others-oriented or socially conscious approach. For the perspective taking task, participants were given the following instructions (adapted from Galinsky et al., 2006):

Task 1. With your dominant hand, as quickly as you can, snap your fingers five times.

Task 2. With your dominant hand, as quickly as you can, draw a capital "E" on your forehead with the marker provided. Don't worry, the marker is nontoxic, and we will make sure it is removed before you leave today.

Upon completion of the perspective-taking task, participants completed the Self-consciousness Scale (Scheier & Carver, 1985), which include the public self-consciousness subscale in addition to the private self-consciousness and social anxiety subscales. They also completed a word fragment completion task assessing sense of power (Bargh et al. 1995), and the ethics position questionnaire (Forsyth, 1980). The target power-related words included: ""Boss, Control, King, Supremacy, Win, Command, Able, Rule, Wealth, Power". For example, the target power-related word "B_S_", could be completed either as "BASE", or "BOSS", "C_NTR_L" as "CENTRAL" or "CONTROL" and "KIN_" as "KIND" or "KING". The number

of words completed as power-related was used to measure power. The order in which the three

measures (i.e., self-consciousness, power, and ethics position) were assessed was

counterbalanced. Next, participants were accompanied to another room where they were asked to

recall the items they saw in the lab environment. These included ordinary objects that one may

encounter in a lab environment such as whiteboards, computers, lighting fixtures, chairs, tables,

books, cabinets, decorations, plants, projectors, and speakers). The total number of correctly

recalled items was used as a measure of spatial recall. Lastly, subjects were given a funnel

debriefing and dismissed. Not a single participant expressed any suspicion that the experiment

involved environmental factors, or that lighting conditions may have affected their behavior.

Results and Discussion

With a chi-square test, we replicated the effect found in study 1. Bright lighting increased

the likelihood of taking others' perspective (88% in bright condition versus 63% in dim

condition), χ^2 (1, N = 64) = 5.333, $p < .05$, $\varphi = .28$. Hence, participants displayed more socially

conscious behavior in the bright (vs. dim) condition. Our framework was based on the

assumption that bright illumination increases the visual saliency of the environment. We confirm

this assumption by finding that participants in the bright condition recalled more items from their

environment than those in the dim condition ($M_{bright} = 5.16$, SD = 1.22, vs. $M_{dim} = 4.09$, SD =

1.44; $t(62) = 3.17$, $p = .002$). We hypothesized that public self-consciousness (PSC) would

mediate the effect of illumination on perspective-taking. Participants in the bright condition

displayed higher PSC compared to those in the dim condition ($M_{bright} = 16.94$, SD = 2.80, vs. $M_{dim} = 12.91$, SD = 3.62; $t(62) = 4.978$, $p < .001$, $d = 1.24$). Lighting did not significantly affect

private self-consciousness or social anxiety. We examined whether PSC mediated the effects of

illumination on perspective-taking. A bootstrapping analysis (Hayes, 2012; Model 4) confirmed

PSC's mediating influence on the relationship between illumination and perspective-taking; based on 5000 resamples, the 90% bias-corrected confidence interval ranged from 0.04 to 1.89. Addressing alternative explanations, we found that power was highly correlated with perspective-taking, $R^2 = 0.044$, $p < .05$. However, lighting did not influence power or ethical position (ps>.2). Thus, the mediating role of power and ethical position is not supported.

In study 2, we replicated results from study 1 and obtained support for our hypothesized mediation. We found that illumination fosters socially conscious behavior and that public self-consciousness mediates this effect. We also confirmed our assumption that people are more attentive to their surroundings in bright settings. Study 3 replicates these findings and extends it by testing conditions under which lighting affects behavior in seemingly contradicting ways. We address the discrepancy in the literature regarding the social consequences of lighting by examining the interaction between physical (i.e., illumination) and social (i.e., reference groups) environments.

STUDY THREE

The findings from study 2 are consistent with our theoretical framework that lighting effects are driven by an increase in awareness of one's environment. We anticipate that the introduction of an undesirable reference group would reverse the behavioral outcome, leading to more, rather than less, egocentric actions in bright settings. This may seem at odds with results from study 1 and 2, and previous research showing that brightness promotes socially conscious and prosocial behavior (e.g., Zhong, Bohns, & Gino, 2010). On the other hand, it confirms other findings demonstrating that people are more socially-oriented in dim, rather than bright environments. For example, Bohns and colleagues (2010) argue that brightness decreases helping behavior towards strangers and can, for instance, discourage individuals from pointing

out embarrassing situations exhibited by a stranger. Our theory predicts that individuals in a bright environment become more publicly self-conscious; therefore, if the social interaction involves an ingroup member, motivation to act based on social cues should increase (as shown in studies 1-2). However, if the context is comprised of members of outgroups, heightened social consciousness - induced by illumination - would lead to less socially-oriented behavior. In the first two studies, we found that bright lighting increases actions that are considerate of others in a collegiate social setting (i.e., university auditorium and labs). Here, we manipulate reference groups by incorporating a outgroup member in the experiment design (see Bearden & Etzel, 1982; White & Dahl, 2006). We argue that in such conditions bright lighting would lead to more egocentric actions, rather than acting with others in mind.

In this study, we use a non-spatial manipulation of illumination. Zhong and colleagues (2010) showed that darkness can facilitate unethical behavior regardless of actual anonymity. They tested their hypotheses by demonstrating that participants wearing sunglasses are more likely to commit moral transgressions. They suggest that darkness may induce an illusionary sense of anonymity that is not necessarily proportionate to actual anonymity in a given situation. Extending this reasoning, we argue that the behavioral effects of lighting may occur even if actual physical visibility (and hence judgment) of one's behavior is not affected. We test this by incorporating a two-dimensional (i.e., screen-related), rather than three-dimensional (i.e., spatial) manipulation of lighting.

Method

Study 3 used a 2 (reference group: ingroup vs. outgroup) x 2 (illumination: bright vs. dim) between-subjects design. One hundred twenty students (45 males, 75 females) participated in this study in exchange for $10. The procedure was similar to study 2 with a few modifications.

First, to test the role of reference groups we subtly manipulated the relationship between the experimenter and participants. While the experimenter in study 2 was dressed neutrally (i.e., wearing a gray shirt), in this study we had the experimenter dress in a way that conspicuously signaled his affiliation with a certain group. In the ingroup condition, the experimenter wore a gray shirt with the logo of the host university on it. In the outgroup condition, the same experimenter wore a similar shirt with a rival university's logo on it. We pretested the logos from ten different schools with a separate group of twenty students at the host school where we asked participants to indicate how much they associated with each school on a 10-point item scale (1 = not at all, 10 = very much). The host school and the rival school were chosen as the most and least associated school (M_{host} = 9.6, M_{rival} = 2.6). Second, as described earlier, we changed the way illumination was manipulated. Instead of manipulating room lighting levels, we manipulated brightness by setting a 21-inch monitor's brightness to either maximum (i.e., bright condition) or minimum (i.e., dim condition). The experiment was run online using Skype with experimenter and subjects being able to communicate and see each other in real-time. After completing the perspective-taking task participants were debriefed and dismissed.

Results and Discussion

An ANOVA showed that the main effect of illumination was not significant ($p > .1$). However, there was a main effect of reference group on perspective-taking; with more socially conscious perspective-taking (i.e., outward-facing "E") in the ingroup condition (61%) than the outgroup condition (40%), $F(1,119) = 6.57$, $p = .012$, $\omega^2 = 0.046$. This was qualified by the hypothesized two-way interaction of lighting and reference group on perspective-taking, $F(1, 119) = 17.17$, $p < .001$, $\omega^2 = 0.122$. Simple effect tests provided support for our hypothesis. When interacting with an ingroup member (i.e., host school experimenter) participants were

more likely to take others' perspective in the bright condition (77%) versus the dim condition

(47%), χ^2 (1, N = 60) = 5.711, $p < .05$, $\varphi = .30$ - replicating study 2. As predicted, a reversal was

observed in the outgroup condition (i.e., interaction with rival school experimenter), where

participants were more likely to take others' perspective if they were interacting via a dim (60%)

versus bright screen (20%), χ^2 (1, N = 60) = 10.0, $p < .005$, $d = .879$.

In this study, we demonstrated that the identity of social groups alters the way in which

illumination influences behavior. Particularly, while participants in the bright condition were

more likely to take others' view in an ingroup setting, they were actually less likely to do so

when interacting with a outgroup member. Study 3 provides support for our theory on the

interaction of social and physical environments and its role on behavior. In light of these results,

it seems reasonable that bright lighting would lead to more prosocial behavior among ingroup

members and more antisocial behavior among outgroup members. Thus, our findings reconcile

the literature on illumination and help explain reported discrepancies discussed earlier.

STUDY FOUR

Study 4 aimed to replicate and extend previous findings; specifically, by providing

process evidence for another socially conscious behavior – in this case, helpfulness.

Furthermore, this study was designed to simultaneously explore both the mediating role of public

self-consciousness (building on findings from study 2) and the moderating role of reference

group (building on findings from study 3). Covering every component of our conceptual

framework, this study was intended to provide further empirical evidence for the unifying theory

presented in this paper, and how it accounts for previous findings. Specifically, we hypothesized

that bright lighting will lead to higher public self-consciousness, which will subsequently lead to more helpful behavior toward an ingroup member. Conversely, we hypothesized that dim lighting will lead to lower public self-consciousness, which will subsequently lead to more helpful behavior toward an outgroup member.

Method

Two hundred and fifty-six college students (179 females and 77 males) at Miami University participated in the study in exchange for partial course credit. Study 4 used a 2 (reference group: ingroup vs. outgroup) x 2 (illumination: bright vs. dim) between-subjects design. Participants were randomly assigned to complete two (seemingly unrelated) tasks in a bright, or dimly lit room, with illumination set at approximately 1000 or 200 lux, respectively. The study was conducted in a large auditorium-style classroom. First, to test the role of reference groups, we subtly manipulated the relationship between the experimenter and participants. While the experimenter in studies 1-2 did not explicitly make participants aware of their affiliation, in this study we had the experimenter conspicuously state her affiliation with a certain institution. In the ingroup condition, the experimenter stated that the study was as part of a project at the host university. The logo of the host university was displayed on the experiment materials. In the outgroup condition, the same experimenter stated that the study was part of a project at a rival university. The rival university's logo was displayed on the experiment materials. We pretested the logos from ten different schools with a separate group of twenty students at the host school where we asked participants to indicate how much they associated with each school on a 10-point item scale (1 = not at all, 10 = very much). The host school and the rival school were chosen as the most and least associated school ($M_{host} = 9.5$, $SD = 0.88$, $M_{rival} = 4.9$, $SD = 1.58$; $t(19) = 10.81$, $p < .001$.

Following previous studies, participants were not informed that the experimenters were studying illumination and were told instead that they would be completing a study on personal traits. For the first task, participants completed the Self-consciousness Scale (Scheier & Carver, 1985) – used in study 2. After they completed this task participants were told that the experiment was complete. With this step, we ensured that participants did not connect the helpfulness opportunity to the experiment. Next, we measured helpfulness (specifically in a non-monetary form) by adopting the same scenario used in Vohs, Mead, and Goode, 2006; experiment 3. For this task, participants were told that the research team was looking for help coding data. The experimenter explained that each data sheet takes approximately 5 minutes to code and asked participants to indicate how many data sheets, if any, they would be willing to code. They were also asked to provide their contact information, if they were willing to help. The number of sheets each participant indicated that they were willing to code was used to measure helpfulness.

Results and Discussion

We performed a 2 x 2 ANOVA with illumination and reference group as independent variables and helpfulness as dependent variable. We observed a main effect of illumination such that participants were more willing to help in the bright lighting condition (M = 2.87, SD = 6.62) than in the dim condition (M = 1.40, SD = 4.27, $F(1,252)$ = 5.91, p = .016, η_p^2 = .023). We also observed a main effect of reference groups such that participants were more willing to help when interacting with an ingroup member (M = 3.17, SD = 7.23) than with an outgroup member (M = 1.14, SD = 3.10, $F(1, 252)$ = 8.95, p = .002, η_p^2 = .038). Furthermore, we also observed a significant interaction ($F(1, 252)$ = 31.91, p < .001 η_p^2 = .112) in the predicted direction. In the bright lighting condition, participants were significantly more willing to help when they interacted with an ingroup member (M = 5.83, SD = 8.62) compared to an outgroup member (M

= 0.13, SD = 0.62, $t(127) = 5.39$, $p < .001$). The effect reversed in the dim lighting condition, where participants were more helpful when they interacted with an outgroup member ($M = 2.22$, SD = 4.16) compared to an ingroup member ($M = 0.59$, SD = 4.26, $t(125) = 4.12$, $p < .001$).

Moreover, a moderated mediation analysis (Hayes, 2012; model 15, using 5000 resamples) revealed that the mediating influence of public self-consciousness on the impact of illumination on helpfulness depended on the type of reference group. Specifically, the indirect effect of illumination was significant in ingroup conditions (the 95% bias-corrected confidence interval ranged from 0.09 to 1.14), but not in outgroup conditions (the 95% bias-corrected confidence interval ranged from -0.52 to 0.03; the 90% bias-corrected confidence interval ranged from -0.43 to 0.01). With the mediator in the model, the direct effect of illumination on helpfulness was no longer significant. These results provide strong evidence that public self-consciousness can explain the effect of illumination on socially conscious behaviors, in this case helpfulness.

In study 4, we found further evidence that people indeed behave in a more socially conscious manner, in this case by showing willingness to donate their time, when they are interacting with an ingroup member in a brightly lit environment. We found that this increase in social behavior in brightly lit environments is due to an increase in public self-consciousness. This replicates the stream of research showing that bright lighting leads to more pro-social behavior.

Furthermore, we also found evidence that the identity of social groups alters the way in which illumination influences behavior. The effect of illumination on social behavior was found to switch as a function of the social environment. More specifically, being in dimly-lit environments was found to decrease public self-consciousness, therefore leading to more others-

oriented behavior despite interacting with outgroups. Put differently, being in a dimly-lit environment seemed to have helped attenuate the negative impact of an unfavorable reference group and even led to outgroup favoritism for participants with low PSC. This is in line with research by Steidle and colleagues (2011, 2013), and further suggests that their results may have been impacted by the type of social groups used in those studies. Specifically, it may be that dim lighting led to more pro-social behavior in those studies, because participants were asked to interact with people they did not necessarily associate with. The results of study 4 provide support for our hypothesis that public self-consciousness mediates and reference groups moderate illumination's effect on socially conscious behavior, in this case helpfulness. Moreover, it provides solid evidence for the interaction between lighting and social environment that may have resulted in discrepancy in the literature on the social effects of illumination.

GENERAL DISCUSSION

Illumination impacts behavior, but findings to date have been inconclusive. We combine evidence from numerous domains to shed light on the influence of illumination on human behavior, specifically choices and actions with social implications. We ran four studies supporting our hypotheses. We found that illumination increases physical visibility and social awareness, thus boosting socially conscious behavior. In study 1, participants in a room with bright (vs. dim) lighting conformed more to others, donated more, and were more sensitive to fairness. In study 2, we showed that bright lighting makes the environment more salient and public self-consciousness mediates the relationship between illumination and perspective-taking. In study 3, we found that due to its dependence on social awareness, the behavioral effect of lighting reverses in the presence of outgroups. Finally, in study 4 we replicate findings from the

first three studies and provide evidence for the proposed moderated mediation process. In these studies, we demonstrated the effect of lighting on behavior using both spatial and screen-related illumination. Furthermore, on an empirical basis, we dismissed several alternative explanations, particularly related to power and ethics.

Our research contributes to the social psychology, consumer behavior and environment-behavior literature. Our main contribution to social psychology is an explication and consolidation of the effects of illumination on actions with social consequences around one overarching theory that is compatible with previous findings in this area. We demonstrate that illumination can have a significant impact on behaviors in a variety of practical situations. We also contribute theoretically by pinpointing processes involved in this effect. Our work adds to the growing literature in psychology showing that atmospheric aspects of physical environments have a subtle, yet strong impact on people.

Discussing possible avenues for interdisciplinary research in neuroscience, Eberhard (2009) argue that architectural design presents a promising potential application. We believe that an exciting area for future research could involve studying the neurophysiological impact of lighting on human behavior. Higher levels of illumination are associated with increased cortisol levels (Kuller & Wetterberg, 1993) and arousal (e.g., Van Hagen, 2011). In addition, Privitera, Diaz, and Haas (2014) argue that arousal leads to more conscious decision-making. A neurophysiological explanation for our findings could be that bright light increases arousal, which in turn increases conscious decision-making that is more likely to be influenced by higher-level executive functions in the prefrontal cortex (PFC), including social decisions. Neuroimaging documentation of the effects of lighting on behavior can provide a rich and

untapped area for researchers interested in studying the role of atmospheric factors on human behavior.

In the present research, we focused on the influence of illumination (i.e., brightness versus dimness) on social behavior. However, it seems reasonable to expect that other lighting properties such as lighting color may also influence social behavior. For instance, research has shown that feelings of social warmth or coldness can be induced by experiences of physical warmth or coldness, and vice versa (Bargh & Shalev, 2011, IJzerman & Semin, 2009, 2010). Other studies have demonstrated that experiencing physical warmth may create an ontological scaffold for the development of social conceptual and metaphorical knowledge (IJzerman & Koole, 2011; Williams, Huang, & Bargh, 2009). Additionally, there have been a number of studies looking at methods of manipulating perceived temperature in a room without changing the physical temperature (Berry, 1961; Kwallek & Lewis, 1990; Hygge & Knez, 2001). Future studies may move beyond conventional methods of manipulating physical warmth. Specifically, we suggest manipulating perceived physical warmth using lighting color and examining its effects on socially conscious behaviors.

The impact of illumination on human behavior in real world situations warrants further attention and provides an exciting arena for future research. The majority of studies on psychological effects of lighting, including this one, have been performed in controlled lab environments (Gardner & Siomkos, 1986; Baker, Levy, & Grewal, 1992). A literature review revealed only two studies that have been conducted in real world settings (see Cuttle & Brandston, 1995; Areni & Kim, 1994). In one of these studies, patrons were recorded in stores. They were found to examine and handle significantly more items under bright lighting conditions than under soft lighting conditions (Areni & Kim, 1994). Future studies should pursue

opportunities to explore the social and psychological consequences of illumination in real world settings such as retail stores, courthouses, restaurants, hotels, banks, hospitals, and urban settings.

Our research has practical implications for managers who often rely on rules of thumb regarding lighting, rather than rigorous scientific knowledge. Illumination guidelines based on our findings can easily be applied to visual merchandising, retail and website design strategies. For instance, such guidelines may be used to design fundraising stages or charity websites that facilitate philanthropy, or develop e-commerce websites and advertising messages that increase consumers' reliance on product reviews.

Evidently, lighting profoundly influences human behavior. As the 19th century author Sebastian Kneipp mentioned in his book "Thus Shalt Thou Live": "Now, if light exercises such a power over other created beings, why should it not also have a distinct influence on the human body and mind?... It may rightly be asserted that a clear atmosphere and light are most powerful in producing a genial disposition in man and therefore have a vital influence on mind and body." Confirming this century-old notion, our work explains how awareness of lighting's impact can help understand individuals' minds and shape their choices.

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