

Sunlight versus Electrical Lighting: A Naturalness Bias in People's Appraisal of Light

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Introduction

In a recent interview, the German light designer Ingo Maurer expressed his dismay regarding the recent European ban on the incandescent light bulb: *“The incandescent light bulb, same as the sun, emits light by means of heating. In its warm glow all colors are reproduced, people look healthier, food tastes better, and one gets tired less easily. Now we are stuck to energy saving lamps and other types of synthetic light”* (Hollands Diep, 2009/2010; p. 158). Interestingly, the light emitted by an incandescent light bulb is regarded as less artificial, than that emitted by modern energy saving lamps. A similar preference for products that are perceived as more natural exists in other domains, including food and medication. Here, this preference is called the naturalness bias (e.g., Rozin, 2005; DiBonaventura & Chapman, 2008). It is considered a cognitive bias as people prefer the natural option (e.g., a drug extracted from plants) even when its synthetically produced counterpart is exactly identical on the molecular level.

In the present paper, we present three studies in which we investigate whether a similar naturalness bias exists in people's appraisal of light. In the first study, we investigate whether the concept “natural” is meaningful in people's appraisal of light. For this purpose, we estimate the perceived naturalness of various types of light as emitted from different sources. We expect that light emitted from the sun is consistently regarded as more natural than electrical lighting, but that even sunlight may lose some of its naturalness when it passes through windows, or is reflected by mirrors. A comparable finding is reported by Rozin (2005), who found that the manipulation of food affects how natural a food product is perceived.

Study 1

Method

Sixty-three persons participated in this laboratory experiment. The mean age was $M = 23.1$ ($SD = 18.1$; range 18 to 75); 41 of which were men. All participants received 2.00 Euro as compensation.

Each participant compared 11 different types of light with regard to its naturalness using forced-choice pair-wise comparisons (see Table 1). The E-Prime 2.1 software (Psychology Software Tools, Pittsburgh, PA) was used for presenting the light type descriptions, and for recording responses. Each participant completed all of the 55 possible comparisons. Each time, participants were instructed to indicate which light they perceived as most natural. Responses were analyzed with the many-facet Rasch model, using the Facets software (Winsteps.com). This method of analysis is similar to Thurstonian scaling.

Results & Discussion

The estimated perceived naturalness of each of the 11 types of light is provided in Table 1. We found significant differences between most pairs of light types, with $p < .05$ (see Table 1). Sunlight entering through an open window was regarded as most natural. As expected, the medium through which sunlight passes significantly affected its naturalness: When entering a room through clear glass, or more so for blinded or translucent glass, it was considered to be less natural than when entering through an open window. Sunlight, however it entered a room, was considered more natural than light from artificial light sources, except for the daylight simulator which was regarded about as natural as sunlight through blinded, or translucent glass. Of the electrical light sources, our participants regarded the

Table 1: Perceived Naturalness of 11 Types of Light (in Logits), Standard Errors of Estimate (SE), and 95%-Confidence Intervals.

Light source	Naturalness	SE	95%-CI
1. Daylight entering through a hole in the wall (e.g., open window) ^a	5.96	0.35	5.27 to 6.65
2. Daylight entering through a clear window ^b	4.06	0.28	3.51 to 4.61
3. Light emitting from a daylight harvester on the roof that brings daylight into the room using mirrors ^c	0.89	0.14	0.62 to 1.16
4. Light emitting from a daylight simulator, powered by the energy grid (grey energy), that mimics daylight perfectly in all its aspects ^d	-0.17	0.11	-0.39 to 0.05
5. Daylight entering through a blinded or translucent window ^d	-0.23	0.11	-0.45 to -0.01
6. Light emitting from incandescent bulbs powered by solar panel ^e	-0.68	0.1	-0.88 to -0.48
7. Light from energy saving light bulbs powered by energy grid (grey energy) ^f	-1.48	0.1	-1.68 to -1.28
8. Light emitting from incandescent bulbs powered by energy grid (grey energy) ^f	-1.67	0.1	-1.87 to -1.47
9. Light emitting from white solid state (LED) lamps powered by energy grid (grey energy) ^f	-1.73	0.1	-1.93 to -1.53
10. Light emitting from fluorescent (TL) tubes powered by energy grid (grey energy) ^g	-2.45	0.11	-2.67 to -2.23
11. Light emitting from colored solid state (LED) lamps powered by energy grid (grey energy) ^g	-2.51	0.12	-2.75 to -2.27

Note. Different superscript letters indicate significant differences with $p < .05$.

incandescent light bulb as emitting the most natural light, at least when powered by a solar panel. The fluorescent (TL) tubes and colored solid state (LED) lamps were regarded to emit the least natural light.

Study 2

Having established that the concept “natural” has meaning in people’s appraisal of light and light sources, we will now test whether this may indeed lead to a cognitive bias in people’s decision making. For this purpose, we use a decision making paradigm common in research on the naturalness bias. Additionally, we take into account a recent alternative explanation for the naturalness bias: That it results from people not believing that synthetic products can be identical (e.g., on the molecular level) to their natural counterparts (Li & Chapman; in press).

Method

One-hundred persons were contacted via email to fill out an online questionnaire. Seventy-six of them completed the survey. The mean age was $M = 29.5$ ($SD = 8.6$; range 16 to 63); 33 of which were men. They received 1.00 Euro as compensation.

The survey consisted of three questions. First, participants read descriptions of two rooms, and selected the room (A or B) they preferred most:

“Room A is lit up with light from a daylight harvester. This is a device on the roof which collects the sun light and transfers it using mirrors into the room”.

“Room B is lit up with light from a daylight-simulator. This is a ceiling lamp (powered with electricity from a solar panel) that mimics daylight perfectly in all its aspects”.

They were instructed to focus on the quality of the light in the room, and to ignore the specifics of the luminaire (e.g., costs or energy consumption). The order of the rooms, and thus the labeling of the rooms, was counterbalanced across participants.

Subsequently we asked participants to reflect on why they chose a particular room (i.e., A or B). All but three of the participants answered this question. Finally, people were asked to read a description of a new daylight simulator in which it was claimed that the

emitted light is identical to daylight in all its aspects. Participants indicated how strongly they believed in this claim using a 10-point scale ranging from 1 (not at all credible) to 10 (absolutely credible).

Results & Discussion

Contrary to our expectations, we did not find a clear preference for light from the daylight harvester (i.e., 57%) over light emitted by the daylight simulator, with $p = .30$ (Binomial test). The credibility of daylight simulation cannot explain the, in this case, absence of a naturalness bias. On average, our participants did not strongly believe that a daylight simulator can emit light that is identical to natural daylight, with an average credibility of $M = 6.1$ ($SD = 1.7$). Moreover, the perceived credibility of daylight simulation did not correlate with an individual's choice of rooms, with $r_{pt-biserial} = .08$ and $p = .50$.

Our participants' comments on why they chose a particular room, however, proved more insightful. We identified three main themes: naturalness-related reasons, practical reasons, and comments indicating that people did not fully understand daylight harvesting. Sixty-five of the 73 comments could be classified under one or more of these themes.

In total, 56.6% of the participants gave a naturalness-related reason. Typical such comments were "Rather real sunlight, than something that mimics it" or "The daylight harvester provides pure sunlight, not simulated sunlight". A statistically significant proportion of these people chose the daylight harvester room ($p < .01$; Fisher's exact test). At the same time, 21.1% of the comments included practical reasons for not preferring the daylight harvester, such as "With the simulator, one is not 100% dependent on the sun", or "A daylight simulator also works during the evening". A marginally significant proportion of these participants chose the daylight simulator room ($p = .08$). Finally, 14.5% of the comments reflected that participant did not fully understand the concept of a daylight harvester: "I cannot imagine a room full of mirrors" or "Mirrors that reflect sunlight will be too bright." Taken together, these results indicate that a

naturalness bias may exist in people's appraisal of light, but that functional aspects of the lighting and a misunderstanding of daylight harvesting may have confounded the results. Therefore, we repeated Study 2 with slight changes to the questions.

Study 3

Method

A different group of 100 persons were contacted via email to fill out an online questionnaire. Seventy-seven completed the survey. The mean age was $M = 28.4$ ($SD = 6.7$; range 20 to 54); 39 of which were men. They received 1.00 Euro as compensation.

As in Study 2, participants were asked to select the room (A or B) they preferred most:

A: of the total amount of light during a day:

- 80% is extracted using a so-called daylight harvester on the roof, which collects daylight and transfers it into the room using glass fiber.
- 20% is generated with a daylight-simulator (powered with electricity from a solar panel) that mimics daylight perfectly in all its aspects.

B: of the total amount of light during a day:

- 80% is generated with a daylight-simulator (powered with electricity from a solar panel) that mimics daylight perfectly in all its aspects.
- 20% is extracted using a so-called daylight harvester on the roof, which collects daylight and transfers it into the room using glass fiber.

The instructions were similar to Study 2, but we stated explicitly that the total amount of illumination was similar for both rooms. This time, we also included an image of what the luminaires in the rooms may look like (see Figure 1).

In the remainder of the article we will call room A the daylight harvester room, and room B the daylight simulator room. Consistent with our naturalness bias hypothesis, we expect people to choose the daylight harvester over the simulator room. The remainder of the questionnaire and the



Fig. 1: The photograph of a ceiling luminaire as used in Study 2 to illustrate to participants how the lighting system in rooms A and B may look.

classification procedure for the comments to the open question were similar to Study 2.

Results & Discussion

Consistent with our naturalness bias hypothesis, a larger proportion of participants preferred the daylight harvester (69%) over the daylight simulator room, with $p < .01$ (Binomial test). As before, most (50.6%) of the people stated naturalness-related reasons. This time, only 6.5% of the participants mentioned practical reasons, and only one comment was categorized as reflecting a misunderstanding of daylight harvesting. In contrast to Study 2, we found no significant differences in choice behavior between people that did or did not make a certain type of comment ($p \geq .17$).

As in Study 2, our participants, on average, only moderately believed that a daylight simulator can emit light that is identical to sunlight, with $M = 5.7$ ($SD = 2.0$; range 1 to 9). This time, we found a small correlation between perceived credibility of daylight simulation and room choice, with $r_{pt-biserial} = -0.29$ and $p < .01$. A stronger belief in daylight simulation makes people less prone to choose the naturally framed option. This small correlation, however, cannot explain wholly the observed choice behavior.

General Discussion

Taken together, the three studies make our hypothesis plausible that a naturalness bias exists in people's appraisal of light. As expected, we found sunlight to be perceived as more natural than electrical light, and that

the manner and degree in which sunlight is transformed, for example by reflective surfaces, decreases its perceived naturalness. Additionally, we provided evidence that perceptions of naturalness may indeed lead to a cognitive bias in people's decision making with respect to light.

The naturalness bias in people appraisal of products is generally explained to have an ideational (i.e., a normative) and/or an instrumental basis (Li & Chapman, in press). We are currently investigating whether the preference for natural light is mostly normative, or is grounded in people's instrumental beliefs with respect to the mental and behavioral consequences of being exposed to sunlight (e.g., with respect to health, performance, and concentration; see, e.g., Veitch, Hine, & Gifford, 1993).

There are two limitations to the present studies. First, we relied solely on written descriptions of light, rather than on direct experience with it. Second, we focused exclusively on people's appraisal of light. It would thus be interesting to test whether perceptions of naturalness also affects the behavioral outcomes of being exposed to different types of light (e.g., performance).

Despite these limitations, our results are of potential interest to light designers and manufacturers, and to researchers interested in the psychological effects of light on people.

References

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