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Enlightened thoughts: Associations with daylight versus electric light, preference formation, and recovery from stress

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Introduction

Light is often used as a metaphor for good versus bad in our daily language. Expressions like ‘the bright side of life’ and ‘a bright or even brilliant person’ illustrate that we often associate light versus dark with respectively the good versus bad. These associative patterns are an important component in theories explaining preference formation and evaluation, with associative processes affecting implicit evaluations. These implicit evaluations, in turn, form the basis of further evaluation (Strack & Deutsch, 2004).

In this paper, we investigated whether the type and valence of associations evoked by daylight differed from associations evoked by electric light. In addition, we investigated how these associations were related to both preference formation and restorative outcomes.

Several studies contrasting words and symbols in black versus white font indicate that light is associated with positive valence and dark with negative valence (Lakens et al., 2012; Meier et al., 2007; Okubo, & Ishikawa, 2001). In addition to more positive associations, people also generally *prefer* light over dark pictures and sunny environments over overcast environments (Beute & de Kort, 2013). One study even indicated that merely thinking of bright environments while under hypnosis resulted in remission of depressive symptoms for patients suffering from Seasonal Affective Disorder. These and other studies demonstrate that the light versus dark contrast is strong, meaningful, and reflected in associations, preferences, and generally beneficial effects.

The contrast between natural and electric light is also relevant to the lighting domain. Studies generally report more positive beliefs for daylight versus electric light with regard

to mood, performance, and health effects (e.g., Veitch, & Gifford, 1996). These beliefs could be due to a naturalness bias (Haans, 2014), with natural light preferred over electric light because it is more natural.

In two studies, we investigated associations with, and preference for daylight versus electric light and we tested the relation between these and restorative outcomes. We employed words and images as stimuli rather than exposure to real daylight, to avoid confounds of view content and differences in temporal and spectral composition of the light, for which effects are already well established. Using words to evoke associations has been used extensively in earlier research concerning associations and meaning of concepts (see Osgood, 1957).

We hypothesized that daylight would generate more positive associations than electric light. We further expected that daylight would render more positive preference ratings and that this beneficial effect of daylight on preference would be mediated by the valence of association.

Study One

The first study tested the associations with, and preference for daylight versus electric light. We also explored the efficacy of words versus text to evoke associations, as we suspected that most people do not consciously perceive light in images and would therefore generate associations with features in the displayed environment rather than with the light setting.

Method

Design

A survey-based 3 (association generation method) x 2 (light source) mixed design was employed. Association generation methods between participants (words vs. images vs.

images with implicit instructions) was manipulated between groups, and light source (daylight vs. electric light) within groups.

Respondents

In total, 67 respondents completed the survey (30 females). Their age ranged between 18 and 52 ($M = 25.24$ ($SD = 4.19$)).

Manipulations

Three different methods were used to evoke associations with daylight versus electric light. Two methods employed images of virtual office. Similar virtual environments -matched in overall brightness- were used, with only light source differing between the pictures, see Figure 1 for an example.

In the two Image methods, respondents received different association instructions. These instructions were either to associate with the images (Image Implicit), or with the light setting in the images (Images Explicit).

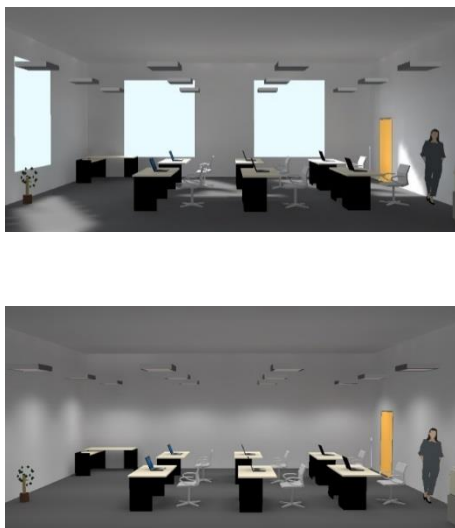


Fig. 1: Example images used

In the Text condition, respondents were asked to generate associations with the following words; *sunlight*, *daylight*, *lamp*, and *electric light*.

Task: Association generation

Respondents were instructed to write down all associations that came to mind, even if they were strange. For each word or image, they could generate between three and five associations. Table 1 displays some

example associations generated in the text condition.

Table 1: Example associations in the text condition

Daylight	Electric light
'Sunshine'	'Blue'
'Vitamin D'	'LED'
'No sleep'	'Street lighting'
'Need it'	'Philips'
'Yellow'	'Not sharp'
'Happy'	'Cold light'
'Morning'	'Night table'
'Freedom'	'Studying'
'Blue sky'	'Evening'
'Football'	'Switch'

Measures

Association ratings After the generation phase, participants rated each association on valence ranging from 1 (very positive) to 7 (very negative). Similar scores were obtained for health, energy, and relaxation. All scores were reverse coded for analyses so that high scores indicated more positive outcomes.

Preference was measured by asking participants how [pleasant, attractive, positive] it would be to spend one hour in the light setting (after Staats, Kieviet, & Hartig, 2003), on a scale ranging from 1 (not at all) to 7 (to a high degree).

Results

First, we investigated whether daylight induced more positive associations than electric light did, which appeared to be the case ($F(1,65) = 79.6$, $p < .001$, $\eta_p^2 = .55$)¹. Similar results were found for health ($F(1,65) = 66.9$, $p < .001$, $\eta_p^2 = .51$), energy ($F(1,65) = 92.2$, $p < .001$, $\eta_p^2 = .58$), and relaxation ($F(1,65) = 41.6$, $p < .001$, $\eta_p^2 = .39$). On all variables, the text condition scored overall more positive than the image conditions ($F(2,65) > 5.4$, $p < .05$). No interaction between association generation method and light source was found, indicating that method of association generation did not affect the direction of outcomes.

Second, we established that higher preference ratings were found for daylight than for electric light ($F(1,64) = 191.5$, $p < .001$, $\eta_p^2 = .75$).

¹ Effect sizes are included. However, for space considerations, the means and SD are not included.

Third, mediation analyses were performed to see whether the valence of associations mediated the effect of light source on preference ratings, which appeared not to be the case (Indirect effect = .02, $p = NS$). No mediation effects were found for health, energy, and relaxation either.

Discussion

In Study One, we established that daylight generates more positive associations and higher preference ratings than electric light does. Counter to expectations, these associations did not mediate the effect of light source on preference formation.

Study Two

In Study Two, the first aim was to replicate the difference in valence of associations and preference between natural and electric light in a between subjects experiment, as associations have been found to depend on the context in which stimuli are presented (Gawronski & Bodenhausen, 2006). We further studied whether the associations influenced recovery of mood and cognitive performance after stress induction.

Method

Design

A between-subjects design was run with Light source (Daylight vs. Electric light) as between subjects variable.

Participants

In total, 64 participants (32 females) participated in the study, their age ranged between 18 and 35, with a mean of 22.41 ($SD = 3.44$).

Procedure

At baseline, mood and cognitive performance were measured, after which all participants completed a stress induction task. After completing the mood questionnaire for the second time, participants generated associations to daylight or electric light-related words. Participants then filled in their mood for the third time and cognitive performance was measured for the second time. Last, they

rated their associations on valence, health, energy, and relaxation and the light-related words on preference, beliefs, and perceived restorativeness. After the experiment was finished, participants were thanked and paid for their participation.

Manipulation – Daylight vs. electric light

The following words were used to evoke associations for daylight: *daylight*, *sun*, and *sunlight*. For electric light, the words were: *electric light*, *lamp*, and *artificial light*. Words were presented in random order.

Manipulation – Stress induction

The retail task (adopted from Häusser, Mojzisch, & Schulz-Hardt, 2011) was used to induce stress. In this task, participants were required to compile a computer package consisting of a screen, desktop, and printer. For each component, three alternatives were given and they were instructed to make maximal use of a given budget. The time span for the trials decreased throughout the assignment. In total, they completed 35 trials.

Measures

Preference and association scores were measured similar to Study One.

Mood was measured with Visual Analogue Scales. On three scales ranging from 0-100 mm, participants were asked to indicate how they felt on three dimensions; tension, energy, and hedonic tone.

Performance was measured with the Sustained Attention to Response Task (SART). Digits ranging from 0 to 9 were displayed and participants were asked to respond as quickly as possible to the appearance of a digit by pressing the spacebar, except when the number '6' was displayed.

Results

As in Study One, associations for daylight were more positive than those for electric light. Daylight scored higher on valence ($F(1,62) = 39.4$, $p < .001$, $\eta_p^2 = .39$), health ($F(1,62) = 32.7$, $p < .001$, $\eta_p^2 = .35$), energy ($F(1,62) = 4.0$, $p = .049$, $\eta_p^2 = .60$), and relaxation ($F(1,62) = 16.3$, $p < .001$, $\eta_p^2 =$

.22). Furthermore, higher preference ratings were again found for daylight than for electric light ($F(1,62) = 34.8, p < .001, \eta_p^2 = .36$). Again, the associations did not significantly mediate the effect of light source on preference.

Neither mood nor performance on the SART task was affected by our manipulation, so the association task with either daylight or electric light did not affect restorative outcomes.

General discussion

The aim of this research was to investigate whether daylight, in comparison to electric light, evokes more positive associations and receives higher preference ratings. Furthermore, we wanted to investigate whether the valence of associations predicts preference and restoration.

In both a within- and between-subjects study, we consistently found that associations with daylight received more positive scores on valence, health, tension, and energy than electric light did. These results corroborate previous research that reported more positive beliefs for the effects of daylight on mood and health than for electric light (Veitch, & Gifford, 1996).

Daylight also consistently received higher preference scores than electric light. However, no relation was found between associations and preference formation.

Thinking of daylight versus electric light did not appear to encompass restorative potential. This finding differs from results of Richter and colleagues (1992) who found restorative effects of imagining being in a bright environment while under hypnosis. However, we used a shorter and more subtle manipulation than they did.

To conclude, this research has indicated that besides biological relevance, light also affects us through psychological pathways. Extending association research beyond the comparison of light versus dark, we found that the light source, in particular the naturalness dimension, is also of central

importance to this psychological relevance of light.

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