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Boomsma, Christine; Steg, Linda

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The effect of information and values on acceptability of reduced street lighting

Christine Boomsma*, Linda Steg

University of Groningen, Faculty of Behavioural and Social Sciences, Department of Psychology, Grote Kruisstraat 2/1, 9712 TS Groningen, The Netherlands

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ABSTRACT

This research examined whether provision of information on the environmental impact of street lighting affects the acceptability and perceived social safety of reduced street lighting levels. We argued that such information should particularly affect acceptability and safety judgements of individuals who value these environmental benefits, that is, those with strong biospheric values. Participants viewed virtual representations of a residential street where street lighting levels were varied. As expected, low lighting levels were seen as more acceptable, while high lighting levels were seen as less acceptable when information on the environmental impact of street lighting was provided to individuals that strongly endorsed biospheric values. Support for the expectation that these increases in acceptability of lower lighting levels would trigger a process of rationalisation leading individuals with strong biospheric values to downplay consequences opposing value-driven views was mixed. Stronger effects were found when participants could compare different lighting levels directly. The study suggests that value-congruent information on the environmental benefits of reduced street lighting can increase acceptability of reduced street lighting.

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1. Introduction

Street lighting has several functions, such as increasing pedestrian and traffic safety, reducing opportunities for crime, and encouraging more effective street use which could strengthen informal social control. Studies have indicated that street lighting tends to have a positive impact on actual safety by, amongst others, improving visibility (Welsh & Farrington, 2007, 2009). However, street lighting represents one of the major end-use sectors when it comes to electric lighting energy use; it can be responsible for up to 70% of total municipality energy use (Mills, 2002; Ministry of Housing, Spatial Planning and the Environment, 2008). So, reducing street lighting might help towards achieving carbon reduction goals and realise substantial cost savings proposed by local and national governments.

As with other energy policies, street lighting policies need public acceptability to be successful (Steg, Dreijerink, & Abrahamse, 2005; 2006). But given the proposed important role of street

lighting in promoting feelings of safety (cf. Loewen, Steel, & Suedfeld, 1993), achieving public acceptability of reduced street lighting might prove difficult. This is illustrated by reactions to recent reductions in street lighting in the United Kingdom (BBC 2010, September 7; 2011, December 22). However, research has indicated that acceptability of reduced street lighting policies can be achieved if feelings of safety are not threatened (Boomsma & Steg, in press).

This paper proposes two ways to increase acceptability of reduced street lighting while safeguarding feelings of safety. This is based on conceptualising acceptability of reduced street lighting as an attitude. Attitudes can be defined as an overall evaluation of an object or thought (Bohner & Wänke, 2002); for energy-related policies this evaluation involves a trade-off between the positive and negative consequences of an energy-related policy (De Groot, Steg, & Poortinga, 2014). Within the context of street lighting, individuals are expected to be more accepting of reductions in street lighting if the perceived negative effects (i.e. reductions in safety) are low (or reduced), and/or when the perceived positive effects are high (or enhanced). This paper proposes two ways, based on previous and current research, by which this can be achieved. First, by making changes to the physical environment to increase feelings of safety. Second, by increasing individual awareness of the positive effects of reduced street lighting (i.e. the environmental benefits).

* Corresponding author. Present address: Plymouth University, School of Psychology, Drake Circus, Plymouth PL4 8AA, United Kingdom.
Tel.: +44(0) 1752 584838.

E-mail addresses: christine.boomsma@plymouth.ac.uk (C. Boomsma), e.m.steg@rug.nl (L. Steg).

1.1. The relationship between street lighting levels and perceived social safety

We define feelings of safety or perceived social safety as a general cognitive response (see Kanan & Pruitt, 2002; Rountree & Land, 1996) reflecting the feeling of being protected against danger caused by, or threatened to be caused by, human actions in the public sphere. Potential reductions in perceived social safety are assumed to be a negative consequence of reduced street lighting; studies have shown that feelings of safety can decrease under low lighting conditions (e.g. Blöbaum & Hunecke, 2005). Lack of natural surveillance could reduce actual safety, and therefore people feel unsafe. Perceived social safety, compared to actual safety, is particularly important when examining acceptability of reduced lighting levels. The same situation might be perceived differently, in terms of safety, depending on the individual. That is, actual safety may not result in perceived social safety: no real dangers need to be present for individuals to feel unsafe (Park, Calvert, Brantingham, & Brantingham, 2008). Yet, actual safety is important to consider; an environment may be perceived as safe, but if data indicates actual safety is low then action is needed.

With respect to perceived social safety research has shown that people tend to perceive street lighting as an important environmental factor in increasing feelings of safety (Loewen et al., 1993). But, building and street design can influence the effect that lighting levels have on perceived social safety (cf. Blöbaum & Hunecke, 2005; Fisher & Nasar, 1992). Furthermore, a recent study by Boomsma and Steg (in press) showed that this was also reflected in acceptability ratings. Specifically, lower lighting levels can be perceived as safe and acceptable when individuals perceive that it is easy to escape the setting in case of danger. This refers to the concept of low entrapment (Nasar, 2000; Nasar & Fisher, 1993), and represents an open area such as a wide street. Thus, potential reductions in perceived safety associated with reduced street lighting can be limited by making changes to the built environment where this is possible.¹ For instance, by aiming to reduce levels of entrapment when designing a new street lay-out or neighbourhood, or by implementing cuts in street lighting in specific settings which offer sufficient opportunities to escape. This in turn can increase public acceptability of changes in street lighting levels (Boomsma & Steg, in press).

The question remains whether acceptability of reduced street lighting can also be achieved by targeting individuals directly. Can the acceptability of reductions in street lighting be enhanced by stressing the benefits of it, thereby reducing the relative importance of the potential negative effects (as compared to the expected positive effects) of reduced street lighting? This is the key question we will address in this paper. This paper adds to previous research by examining whether raising awareness of the environmental benefits of reduced street lighting levels can increase their acceptability and related feelings of safety, and whether the effects of such information provision depends on individual values, in particular pro-environmental values.

1.2. The effect of information and values on the acceptability of reduced street lighting

Although individuals might be aware of the negative consequences of reduced street lighting (notably perceived social safety)

they might be less aware of its environmental benefits. For an expert the link between reduced street lighting and environment benefits may be self-evident, however it could be that the general public is less aware of this link. To form a favourable attitude towards reduced street lighting policies individuals need to be aware and acknowledge the benefits related to lower lighting levels. Providing information on the environmental consequences of street lighting could increase awareness of these benefits.

1.2.1. Information and pro-environmental values

Such information should be particularly valued by those individuals who see protection of the environment as an important general goal in their life, which is reflected in strong biospheric values (Lorenzoni, Nicholson-Cole, & Whitmarsh, 2007; Schwartz, 1992, 1994; Steg & De Groot, 2012). Values are defined as an overarching goal, varying in importance, which can serve as a guiding principle in life (Schwartz, 1992). Biospheric values reflect concern for nonhuman species or the biosphere. Research has shown that strong biospheric values are generally positively related to pro-environmental beliefs, norms, intentions and behaviour (Nilsson, Von Borgstede, & Biel, 2004; Nordlund & Garvill, 2002; Steg & De Groot, 2012; Stern, 2000). Values guide what individuals find important: people evaluate issues more positively when these have positive consequences for the values they strongly endorse (Schwartz, 1992). Moreover, if information suggests that a valued object or issue will be affected by a decision – interest in that decision will increase (Dietz, 2013).

The reasoning above is in line with research suggesting that values affect pro-environmental behaviour by directing attention towards value-congruent information (Nordlund & Garvill, 2002, 2003; Steg, Perlaviciute, Van der Werff, & Lurvink, 2012; Stern & Dietz, 1994; Stern, Dietz, Kalof, & Guagnano, 1995). On the basis of this, it is expected that individuals with strong biospheric values are more likely to attend to information on environmental impact of street lighting, and base their evaluations of the acceptability of reduced street lighting on its environmental consequences. In contrast, individuals are less likely to respond to information on environmental impacts if they do not value the environment (Nicholson-Cole, 2005).

In conclusion, we propose that a specific choice outcome is seen as more attractive if it supports important values (cf. Verplanken & Holland, 2002). Hence, we expect that information on the environmental impact of street lighting will be particularly effective in increasing acceptability of reduced street lighting for individuals with strong biospheric values, while it should reduce acceptability of high lighting levels for individuals with strong biospheric values. Environmental information is not expected to affect the acceptability of street lighting for individuals with weak biospheric values. To the authors' knowledge, this question has not been explicitly addressed in research on acceptability before.

Given that specific evaluations about costs and benefits and acceptability judgements are rooted in values (De Groot et al., 2013; Short & Rosa, 2004; Stern, Dietz, & Guagnano, 1998), may such information provision also affect the evaluation of the perceived costs of reduced street lighting (i.e. perceptions of social safety)?

1.3. The effect of information and values on perceived social safety

Scholars have suggested that individuals tend to highlight the consequences of a decision that supports value-driven views (Whitfield, Rosa, Dan, & Dietz, 2009), whereas they will not highlight (or even downplay) those consequences of a decision that threaten their value-driven views (De Groot et al., 2013; Steg, Bolderdijk, Keizer, & Perlaviciute, 2014). For example, De Groot et al. (2013) found that individuals with strong egoistic

¹ It should be noted that providing opportunities to escape does not have to be limited to making changes in the physical environment. Entrapment also has a social dimension related to the inability of contacting people who can help (Nasar & Fisher, 1993).

values (i.e. individuals interested in maximising their own individual outcomes) perceived more benefits (e.g. cheaper energy) and fewer risks (e.g. public safety) with regards to nuclear energy. As a result, strong egoistic values were related to greater acceptability of nuclear energy. Strong biospheric values on the other hand were related to perceiving more risks, and were not related to the perception of benefits of nuclear energy. Moreover, individuals with strong biospheric values were less likely to accept nuclear energy. We suggest that a similar process could lead individuals to downplay potential feelings of unsafety when accepting reduced street lighting policies in response to providing information on its positive environmental consequences (which is particularly likely among those with strong biospheric values, as argued above).

This effect is expected to result from a process of motivated cognition and rationalisation. That is, people tend to strive for their cognitions, or attitudes and behaviour, to be consistent with each other (cf. cognitive dissonance theory; Festinger, 1957). However, sometimes cognitive inconsistencies do take place leading to an unpleasant feeling that serves as a cue for errors in one's system of beliefs (Gawronski, 2012). In response, individuals might change their cognitions, attitudes, or behaviours so that these are more consistent with each other. For instance, someone who smokes might be aware of the negative health consequences of smoking, which leads to an inconsistency in cognition and behaviour. This person might then search for evidence that the harmful effects are minimal, or that the benefits outweigh the costs in this case in order to reduce unpleasant feelings due to cognitive dissonance (Fotuhi et al., 2013; Lipkus, Green, Feaganes, & Sedikides, 2001).

Similarly, an individual might evaluate reduced street lighting policies as more acceptable because of the environmental consequences of street lighting (which is in our case depicted in the provided information). This individual might feel uncomfortable with the thought that reduced street lighting could threaten his or her perceived social safety, as this implies an inconsistency between different cognitions (or beliefs). In this case, this individual will be motivated to reduce the possible inconsistencies in his or her cognitions in order for them to be consistent again (Festinger, 1957). One way of doing this is by downplaying the potential decrease in perceived social safety, which would mean that beliefs about perceived social safety support (rather than threaten) favourable acceptability judgements. For individuals with strong biospheric values environmental benefits are of particular importance (cf. Steg & De Groot, 2012; Stern, Dietz, & Kalof, 1993) and thus they are particularly likely to be motivated to downplay the potential decrease in perceived social safety.

In sum, we assume that individuals are motivated to avoid a conflict between cognitions, thus, an increase in acceptability for low lighting levels as described above is expected to coincide with an increase in perceived social safety of settings with low lighting levels (for individuals with strong biospheric values). At high lighting levels the conflict between cognitions is less obvious, as these are already evaluated as safe, and hence, these evaluations do not necessarily interfere with a reduction in acceptability.

1.4. Hypotheses

In sum, the novel contribution of the current research is that we will study the extent to which the effect of environmental information on the acceptability of reduced street lighting depends on biospheric values strength, and whether this in turn affects perceived social safety of settings with reduced lighting levels. Based on the above we propose the following hypotheses:

Table 1

Number of participants in each between subjects condition.

	No information	Information
Weak biospheric values	<i>N</i> = 16	<i>N</i> = 19
Strong biospheric values	<i>N</i> = 21	<i>N</i> = 17

Hypothesis 1 First, we aim to replicate findings from previous research (Blöbaum & Hunecke, 2005; Boomsma & Steg, in press). We expect to find a main effect of lighting level on acceptability of lighting levels and perceived social safety. That is, individuals are expected to perceive higher lighting levels as more acceptable and safer.

Hypothesis 2 Second, we aim to extend previous research. Notably, we expect a three-way interaction effect of environmental information, values, and lighting levels on acceptability and perceived social safety of lighting levels.

- Information on the environmental impact of street lighting is expected to increase acceptability of low lighting levels, and decrease acceptability for high lighting levels for individuals who strongly endorse biospheric values, but not for those with weak biospheric values.
- Information on the environmental impact of street lighting is expected to increase feelings of safety for low lighting levels for individuals who strongly endorse biospheric values, but not for those with weak biospheric values.

2. Method

2.1. Participants

The sample consisted of 73 university students and local authority staff from the north of the Netherlands (32 men; 41 women).² Students received course credits as a reward for their participation. The participants varied in age between 18 and 64 years old (*M* = 33; *SD* = 12.48).

2.2. Design and procedure

A $5 \times 2 \times 2$ mixed design was used with lighting (Low2, Low1, Middle, High1, High2) as a within subject factor and information (no information; information) and biospheric value strength (weak biospheric values; strong biospheric values) as between subject factors (see Table 1). In the experiment participants were asked to evaluate five movie-clips on lighting level acceptability and perceived social safety. To ensure all participants experienced the same lighting levels during the experiment, participants sat in a dark room (lights switched off, no windows) about 60 cm in front of a computer (17" monitor, 1024 × 768 resolution, 85 Hz refresh rate). Monitor settings were kept constant throughout the experiment and participants were given a few minutes to adjust to the lighting level in the room.

Supplementary video related to this article can be found at <http://dx.doi.org/10.1016/j.jenvp.2013.11.004>.

At the start of the experiment participants were randomly assigned to one of two information conditions. Half of the participants received the following information (based on: McKinney &

² Inclusion of sample source (university vs. local authority) as a covariate in the analyses discussed in this paper did not lead to any changes in the results. Therefore, we report results for the full sample only.

Fig. 1. Movie-stills of the five movie-clips used in the experiment.

Schoch, 2003; Ministry of Housing, Spatial Planning and the Environment, 2008) on the environmental impact of street lighting:

“There is an enormous amount of artificial lighting on our planet. Consider for example the fact that under natural conditions it would be possible to see 10,000 stars in a city. However, due to artificial lighting it is possible to see only around 100 stars. This excess of light has a negative effect on nature.

Hundreds of thousands hatching sea turtles die every year because they are confused by the artificial lighting behind the beach. Normally they would gravitate towards the brighter, more reflective sea but due to the excess of artificial light they walk in the wrong direction. In the Netherlands street lighting also has a negative effect on wild animals and plants. For example, birds start singing earlier which is costing them vital energy.

Next to the disrupting effect on wildlife, energy used for street lighting also adds to the greenhouse effect. In 2007 street lighting was responsible for 30–70% of total municipality energy-use, which equals 0.63 Mton in CO₂ emissions.”

The other half of the participants received no information. Next, participants were shown five movie-clips on full-screen in which lighting level was varied. Participants were instructed to imagine themselves walking in the depicted scene. After each movie-clip the participants were asked to rate perceived social safety and acceptability of the lighting levels. To prevent order effects, the movie-clips were shown to the participants in a random order. After watching all five movie-clips participants provided comparative judgements of perceived social safety and acceptability of the different lighting levels. Finally, participants filled in an additional questionnaire on values. After the experiment, all participants were thanked and debriefed.

2.3. Materials

2.3.1. Virtual environment movie-clips

To test our hypotheses, the current study exposed participants to a virtual environment where lighting levels were manipulated. Virtual environments can be modified easily and quickly (Park et al., 2008), thereby only manipulating relevant aspects of the environment while keeping all other aspects constant and thus enhancing

experimental control (Pals, 2011). Furthermore, virtual reality has appeared to be a valid tool to study responses to changes in environmental conditions (Bishop & Rorhman, 2003; Boomsma & Steg, in press; Nasar & Cubukcu, 2011; Pals, 2011).

Designers at the University of Groningen Centre for Information Technology developed a 40-s virtual environment movie-clip, modelled on an existing street. Initially five versions of this movie-clip were made depicting five different lighting levels, ranging from low street lighting levels to high street lighting levels. Two street lighting experts helped rank the movie-clips. Efforts were made to ensure that lighting conditions reflected realistic levels and that differences in lighting level between the movie-clips were approximately equal. Based on the experts' judgements one additional low lighting movie-clip was made and one high lighting movie-clip was excluded from the study. Stills from the five movie-clips (i.e. low2, low1, middle, high1, high2) used in the study are depicted in Fig. 1, and the full movie-clips are included as Supplemental Material.

The movie-clips showed the street from the viewpoint of a pedestrian walking through the scene. The street was approximately 20 m wide, thus (low) entrapment levels (cf. Nasar, 2000; Nasar & Fisher, 1993) were kept constant across movie-clips. Clips were identical except for lighting levels; only houses and lighting poles were present.

2.3.2. Questionnaire after each movie-clip

While filling in the questionnaire on acceptability and perceived social safety of lighting levels, a movie-still of the relevant movie-clip was shown on the screen to make sure that participants had the correct movie-clip in mind while filling in the questionnaire.

Acceptability of lighting levels was measured with a four-item scale (Boomsma & Steg, in press). First, participants were asked whether they found the amount of lighting in the setting acceptable (scale ranging from 1 (strongly disagree) to 5 (strongly agree)). Next, participants rated whether in their opinion the amount of street lighting in this setting was bad (1) to good (5), negative (1) to positive (5), and insufficient (1) to sufficient (5). Mean scores were computed for each setting, high scores reflected higher acceptability (Cronbach's alpha ranged between .81 and .96 across settings).

Perceived social safety – This scale was identical to a scale used by Boomsma and Steg (in press) and is based on a perceived personal danger scale developed by Blöbaum and Hunecke (2005). On a scale ranging from 1 (strongly disagree) to 5 (strongly agree) participants rated whether they would not mind to walk along this place unaccompanied; they would take a long detour to avoid this place (recoded); they would quickly get away from this place (recoded); they felt safe at this place; they felt anxious at this place (recoded); they had an unpleasant feeling at this place (recoded); and they felt uneasy at this place (recoded). For each lighting setting mean scores were computed, high scores reflected higher feelings of safety (Cronbach's alpha ranged between .88 and .94 across settings).

2.3.3. Questionnaire after watching all movie-clips

Comparative judgement – Participants were asked to choose which of the five movie-clips depicted the scene in which they still felt safe, and which of the five movie-clips depicted the minimal lighting strength that they still found acceptable, respectively. Movie-stills of all five clips were shown on the screen while participants answered these questions.

Biospheric Values were assessed using a 4-item scale designed by De Groot and Steg (2008), based on Schwartz's value scale (1992). Participants were asked to rate the importance of 13 values as a guiding principle in their lives on a scale ranging from –1 (opposed

Table 2
Mean perceived social safety and lighting level acceptability for each lighting level (SD is depicted between brackets).

	Low2	Low1	Middle	High1	High2
Perceived social safety	2.95 (1.00)	3.39 (.86)	3.71 (.74)	3.78 (.72)	3.92 (.69)
Lighting level acceptability	2.56 (1.24)	3.44 (1.11)	3.74 (.88)	3.90 (.77)	3.92 (.80)

to the values), 0 (not at all important), to 7 (of supreme importance). Four items reflected biospheric values: respecting the earth (harmony with other species); unity with nature (fitting into nature); protecting the environment (preserving nature); preventing pollution (protecting natural resources). Reliability of the scale was good, $\alpha = .90$. Based on a median split (Median = 4.25) a categorical variable was computed representing relatively weak and strong biospheric values. The resulting groups were similar in age (weak values $M = 31$, $SD = 11.90$; strong values $M = 34$, $SD = 12.89$), $t(71) = -1.25$, $p = .214$, $d = .24$, and gender composition (weak values: 40% males; strong values: 47% males), $\chi^2(1, N = 73) = .402$, $p = .526$.

3. Results

3.1. Effect of lighting level on perceived social safety and acceptability

A mixed model ANOVA was conducted with lighting level as a within factor and information and biospheric values as a between factor.³ In line with Hypothesis 1, participants evaluated higher lighting levels as more acceptable, $F(3,221) = 29.89$, $p < .001$, partial $\eta^2 = .30$ (see Table 2), as measured by the acceptability rating provided after each movie-clip. Contrast analyses (see Table 3) revealed that when looking at the difference between each subsequent lighting level, the only significant difference was found between the acceptability of Low2 and Low1. For the remaining lighting levels, there was no significant difference on acceptability when comparing each subsequent lighting level with the previous lighting level. It should be noted that significant differences were found when comparing lighting levels with more than one level difference. But interestingly, compared to the highest lighting level (High2), only the lowest two lighting levels were perceived as significantly less acceptable, Low2: $F(1,69) = 52.14$, $p < .001$, partial $\eta^2 = .43$; Low1: $F(1,69) = 7.62$, $p = .007$, partial $\eta^2 = .10$.

Further supporting Hypothesis 1, participants also felt safer at higher lighting levels compared to lower lighting levels, $F(3,221) = 36.85$, $p < .001$, partial $\eta^2 = .35$, as measured by the perceived safety rating provided after each movie-clip. As can be seen in Table 2, each subsequent lighting level was perceived as safer compared to the previous level. Contrast analyses (see Table 3) revealed that this effect was most pronounced at low lighting levels. As with acceptability, contrast analyses were conducted to test the difference between subsequent lighting levels; differences were stronger when comparing lighting levels at either end of the spectrum, e.g. Low2 vs. High2, $F(1,69) = 71.88$, $p < .001$, partial $\eta^2 = .51$; Low1 vs. High2, $F(1,69) = 30.09$, $p < .001$, partial $\eta^2 = .30$; Middle vs. High2, $F(1,69) = 8.93$, $p = .004$, partial $\eta^2 = .12$.

After seeing all movie-clips participants were asked to report which of the five movie-clips depicted the scene in which they still felt safe, and which they still found acceptable. Overall, the majority

³ Because the sphericity assumption was violated and a relatively small sample size was used, a Huynh-Feldt Epsilon correction was implemented.

Table 3

Contrast analyses comparing each subsequent lighting level with the previous lighting level on lighting level acceptability and perceived social safety.

Comparison	Lighting level acceptability	Perceived social safety
Low2 – Low1	$F(1,69) = 44.06, p < .001$, partial $\eta^2 = .39$	$F(1,69) = 22.53, p < .001$, partial $\eta^2 = .25$
Low1 – Middle	$F(1,69) = 3.67, p = .060$, partial $\eta^2 = .05$	$F(1,69) = 13.44, p < .001$, partial $\eta^2 = .16$
Middle – High1	$F(1,69) = 2.17, p = .145$, partial $\eta^2 = .03$	$F(1,69) = .99, p = .323$, partial $\eta^2 = .01$
High1 – High2	$F(1,69) = .00, p = .960$, partial $\eta^2 = .00$	$F(1,69) = 5.91, p = .018$, partial $\eta^2 = .08$

of participants chose the movie-clip representing the middle lighting level as the setting where they still felt safe. It is not likely that this is due to an order effect as movie-clips were shown to participants in random order, and when making the comparative judgement the movie-stills on the screen were presented in a group and not in one row with the middle lighting level as the middle image. However, due to the fact that the experiment exposed participants to an uneven number of movie-clips, this could still have affected the choice for the middle lighting level. Interestingly, the minimally acceptable lighting level chosen by the majority of participants was slightly lower, namely Low1. This provides some indication that individuals can find lighting levels acceptable although they are perceived as slightly unsafe.

Thus, overall an increase in lighting level led to an increase in perceived social safety and lighting level acceptability. However, there was some indication in the data that the influence of each subsequent increase in lighting level on perceived social safety and acceptability became weaker and even non-significant as lighting levels increased.

3.2. Influence of values on the effect of environmental information on acceptability and perceived social safety for different lighting levels

3.2.1. Acceptability of lighting levels

In line with [Hypothesis 2a](#), a three-way interaction was found between lighting level, information and biospheric values, $F(3,221) = 2.68, p = .044$, partial $\eta^2 = .04$. [Fig. 2](#) depicts the data pattern for individuals with strong biospheric values. As expected, when environmental information was provided, participants with strong biospheric values found low lighting levels more acceptable and high lighting levels less acceptable compared to when no environmental information was provided. When comparing the

Fig. 2. The effect of lighting level and environmental information on lighting level acceptability for individuals with weak and strong biospheric values.

Table 4

Contrast analyses comparing the no information and information condition for each lighting level on lighting level acceptability and perceived social safety, for individuals with weak and strong biospheric values.

Lighting level	Biospheric values	Lighting level acceptability	Perceived social safety
Low2	Weak	$F(1, 33) = 2.13, p = .154$, partial $\eta^2 = .06$	$F(1, 33) = .22, p = .642$, partial $\eta^2 = .01$
	Strong	$F(1, 36) = 8.79, p = .005$, partial $\eta^2 = .20$	$F(1, 36) = 6.34, p = .016$, partial $\eta^2 = .15$
Low1	Weak	$F(1, 33) = .28, p = .604$, partial $\eta^2 = .01$	$F(1, 33) = .10, p = .753$, partial $\eta^2 = .00$
	Strong	$F(1, 36) = 4.27, p = .046$, partial $\eta^2 = .11$	$F(1, 36) = 2.42, p = .128$, partial $\eta^2 = .06$
Middle	Weak	$F(1, 33) = 2.35, p = .135$, partial $\eta^2 = .07$	$F(1, 33) = .02, p = .884$, partial $\eta^2 = .00$
	Strong	$F(1, 36) = .05, p = .823$, partial $\eta^2 = .00$	$F(1, 36) = 4.89, p = .033$, partial $\eta^2 = .12$
High1	Weak	$F(1, 33) = 2.22, p = .146$, partial $\eta^2 = .06$	$F(1, 33) = .01, p = .912$, partial $\eta^2 = .00$
	Strong	$F(1, 36) = .20, p = .660$, partial $\eta^2 = .01$	$F(1, 36) = 3.01, p = .091$, partial $\eta^2 = .08$
High2	Weak	$F(1, 33) = 1.22, p = .277$, partial $\eta^2 = .04$	$F(1, 33) = .18, p = .671$, partial $\eta^2 = .01$
	Strong	$F(1, 36) = 4.61, p = .039$, partial $\eta^2 = .11$	$F(1, 36) = 2.30, p = .138$, partial $\eta^2 = .06$

different lighting levels, a significant difference was found between the information and no information condition for Low2, Low1, and High2 (see [Table 4](#)). As can be seen in [Table 4](#) no significant difference was found between the information conditions for Middle and High1 lighting levels. In contrast, as expected, for individuals with weak biospheric values no effect of environmental information was found on acceptability of any of the lighting levels (see [Table 4](#) and [Fig. 2](#)).

Further support for [Hypothesis 2a](#) was found using the comparative judgements provided by participants after viewing all movie-clips. The comparative judgement ratings were analysed using a Mann–Whitney U test because of the ordinal level of measurement ([Brace, Kemp, & Snelgar, 2009](#)). The test revealed that participants with strong biospheric values reported a lower lighting level as minimally acceptable when environmental information was provided (M rank = 14.03), compared to when no environmental information was provided (M rank = 23.93), $U = 85.50, N_1 = 17, N_2 = 21, p = .005$. As expected, no effect of environmental information was found on the minimally acceptable lighting level for individuals with weak biospheric values, $U = 126.00, N_1 = 19, N_2 = 16, p = .403$ (M rank = 16.63, M rank = 19.63; for information and no information condition respectively).

Fig. 3. The effect of lighting level and environmental information on perceived social safety for individuals with weak and strong biospheric values.

In sum, the effect of information on acceptability of lighting levels depended on biospheric value strength. Lower lighting levels were seen as more acceptable and higher lighting levels were seen as less acceptable when individuals with strong biospheric values received information on the environmental impact of street lighting (as compared to receiving no information), while this information did not affect acceptability judgements of those with weak biospheric values. Also, individuals with strong biospheric values reported a lower lighting level which they still found acceptable when provided with environmental information compared to when no information was provided, while this information did not affect these judgements for those with weak biospheric values.

3.2.2. Perceived social safety of lighting levels

The expected interaction, proposed in [Hypothesis 2b](#), between lighting level, environmental information and biospheric values was not found for perceived social safety, $F(3,221) = .19$, $p = .911$, partial $\eta^2 = .00$. Some support was found for [Hypothesis 2b](#) when examining the ratings of minimally safe lighting levels provided after viewing all the movie-clips together. A Mann–Whitney U test revealed that participants with strong biospheric values reported a lower lighting level where they still felt safe when environmental information was provided (M rank = 13.06) compared to when no information was provided (M rank = 24.71), $U = 69.00$, $N_1 = 17$, $N_2 = 21$, $p = .001$. In contrast, in line with our expectation, environmental information had no significant effect on the minimal lighting level that was still perceived as safe for individuals with weak biospheric values, $U = 110.00$, $N_1 = 19$, $N_2 = 16$, $p = .172$ (M rank = 15.79, M rank = 20.63; for information and no information condition respectively).

This effect led us to re-examine the three-way interaction between lighting level, environmental information and biospheric values for perceived social safety in more depth. [Fig. 3](#) suggests that individuals with strong biospheric values perceived lower lighting levels as slightly safer after environmental information was provided compared to when no information was provided. Exploratory analyses (see [Table 4](#)) revealed that the differences between the information and no information condition were statistically significant for the Low2 and Middle level of lighting only. For those with strong biospheric values, perceived social safety at high lighting levels did not depend on environmental information provision: no significant difference was found for High1 and High2. As expected, for individuals with weak biospheric values no effect of information on perceived social safety was found for any of the lighting levels (see [Table 4](#) and [Fig. 3](#)). But, as the three-way interaction effect was not significant, these results should be interpreted with caution – on their own these results are not strong enough to support [Hypothesis 2b](#).

Overall, we found some support for the suggested effect that individuals with strong biospheric values perceive lower lighting levels as safer when provided with information on the environmental impact of street lighting. When being able to compare the different lighting levels directly, participants with strong biospheric values did report a lower lighting level which they still perceived as safe when environmental information was provided. This information had no effect on the lighting level that was still perceived as safe for individuals with weak biospheric values. However, when evaluating the movie clips separately, no significant three way interaction between lighting level, biospheric values, and information on perceived social safety was found.

4. Discussion

The study aimed to take an individual approach to increase acceptability and perceived social safety of reduced street lighting levels. This extends previous research in this field which has largely

focused on the relationship between the built environment, lighting levels and perceived social safety. Results indicated that, as expected, overall, higher lighting levels were perceived as more acceptable and safer compared to lower lighting levels ([Hypothesis 1](#)). This illustrates part of the challenge in reducing current street lighting levels. We examined whether reduced street lighting levels can be perceived as more acceptable and safe by increasing awareness of the environmental benefits of reductions in street lighting levels. Moreover, the role of biospheric values was explored in this context. We will first discuss the findings with respect to acceptability, followed by a discussion of the findings for perceived social safety.

It was expected that information on the environmental impact of street lighting would increase acceptability of low lighting levels, and decrease acceptability of high lighting levels for individuals with strong biospheric values ([Hypothesis 2a](#)). In line with our expectations, a significant interaction was found between information, level of street lighting, and biospheric values. When information on the negative environmental impact of street lighting was provided to individuals with strong biospheric values, they perceived low lighting levels as more acceptable, and high lighting levels as less acceptable. In contrast, information provision did not affect acceptability ratings for any lighting level for individuals with weak biospheric values. Also, when given the opportunity to compare five lighting levels and select the minimal acceptable lighting level, individuals with strong biospheric values selected a lower lighting level as still acceptable when information was provided compared to when no information was provided, while information did not affect minimal acceptable lighting level of those with weak biospheric values. This is in line with previous research indicating that a choice outcome is perceived as more attractive when it supports important individual values ([Verplanken & Holland, 2002](#)). Specifically, increasing awareness of the perceived benefits of reduced street lighting for a valued topic, in this case environmental quality, can enhance acceptability for reduced street lighting levels for individuals who strongly value the environment, in this case those with strong biospheric values.

Further extending earlier research, we expected that information on the environmental impact of street lighting would not only affect acceptability, but also perceived social safety of reduced street lighting. This follows from the literature indicating that individuals are motivated to form consistent cognitions and beliefs ([Festinger, 1957](#); [Gawronski, 2012](#)). To illustrate, when individuals perceive lower lighting levels as more acceptable due to its benefits for the environment, potential reductions in perceived social safety related to lower lighting levels might be deemed less important so cognitions can remain consistent. By doing so, expected effects on perceived social safety would support rather than threaten more favourable acceptability judgements after information provision. This effect was expected to be particularly likely for individuals with strong biospheric values, as they are more strongly motivated to evaluate reduced street lighting levels as more acceptable in response to the provided information ([Hypothesis 2b](#)).

Support for [Hypothesis 2b](#) was relatively weak; the effect of the predicted three-way interaction between information, lighting levels, and biospheric values on perceived social safety was not statistically significant when the movie clips were evaluated separately. Yet, the effect of information did depend on biospheric value strength when comparative judgements were provided on perceived social safety of the different lighting levels. As expected, participants with strong biospheric values reported a lower lighting level that they still perceived as safe when information on the environmental benefits of reduced street lighting was provided, compared to when it was not provided. In line with our expectations, information provision did not affect feelings of safety for each

lighting level for individuals with weak biospheric values. As the results are not consistent we cannot conclude with certainty that after receiving environmental information, individuals with strong biospheric values are more strongly motivated to downplay potential reductions in perceived social safety (as this may threaten their more favourable acceptability judgements guided by expected environmental benefits), because these individuals strongly value the environmental benefits of reduced street lighting. However, some indication for the suggested effect was found, specifically when individuals were able to compare different lighting levels directly. It is unclear whether being able to make this comparison strengthens the effect, or is even necessary for the effect to occur. Alternatively, the effect of biospheric values and environmental information on perceived social safety might be limited to very specific lighting levels and therefore yielding non-significant effects when evaluations of all lighting levels are analysed together. One possibility is that the effect could occur at those lighting levels where a shift is taking place from non-acceptable to acceptable and safe. Hence, the effect is particularly found when asking participants for the minimal lighting level which they still perceive as safe. This might reflect a recurring pattern found throughout the experiment – stronger effects were found at lower lighting levels. For instance, the effect of lighting level on acceptability and perceived social safety was more pronounced at lower lighting levels. Further research is needed to examine the underlying mechanisms in more detail. Also, limitations to the current study, which are described in the next section, might be a reason for not finding a strong, consistent effect at this time.

4.1. Limitations and future research

Certain limitations of the current study need to be kept in mind when interpreting the results. The sample was relatively small, especially as four between-groups were compared. This may have led to issues concerning statistical power, meaning that the likelihood that the experiment would detect an effect could have been reduced. Another important issue is the measure of biospheric values used in the current research, specifically the use of a median split to distinguish two groups based on biospheric value strength. Although a median split is a common procedure for dichotomising continuous predictor variables, the use of median split analysis had been criticised by a number of scholars. This is mainly due to the potential loss of information about individual differences, potential loss of effect size, and decrease in power (cf. Irwin & McClelland, 2003; MacCallum, Zhang, Preacher, & Rucker, 2002). Research following on from this experiment should consider including a continuous measure of biospheric values in the analyses, or measure biospheric values in a different way.

We conducted a lab study using virtual environment movie-clips, while previous research on the relationship between lighting levels and perceived social safety has often used field studies (e.g. Blöbaum & Hunecke, 2005). Although the ecological validity of lab studies is often weaker compared to field studies, they enhance experimental control because other potentially influential variables (e.g. entrapment, presence of others, weather etc.) can easily be kept constant. The latter is particularly important when investigating specific underlying mechanisms because the high level of experimental control allows for more certainty that the effects were due to the experimental manipulations, without being obscured by other factors (i.e., high internal validity). This method provides an opportunity for future research to (relatively) easily examine other factors not included in the current research such as the effect of the type of area (e.g. a residential street versus an urban environment), or the influence of the presence of other people in the scene. Other aspects of lighting could also be

examined. For instance, scholars have noted that other characteristics of street lighting such as uniformity (e.g. Boyce, Eklund, Hamilton, & Bruno, 2000) and colour (e.g. Knight, 2010) could also be important with regard to perceived and actual safety.

By using movie-clips instead of still images we attempted to increase realism and immersion in the scene. Also, differences in perceived social safety and acceptability between the experimental conditions indicate that the movie-clips were able to elicit different levels of perceived social safety and acceptability. However, future studies could examine whether results can be replicated in a field setting. In particular, due to the use of virtual environment movie-clips the current study could not assess the exact lighting level represented in each clip (in terms of lux-levels). This is an important issue to be addressed in future research, particularly from a practical point of view as it would be interesting to examine the effects discussed in this paper in relation to the current norm of street lighting.

Also, future research could use more general population samples. The current study used a selective sample which might limit generalizability. But, given that results were similar across the sample (consisting of university students as well as local authority employees) this provides us with some confidence in the generalizability of the findings.

4.2. Theoretical and practical implications

The research described in this paper has both theoretical and practical implications. A new approach was used for street lighting research by combining value theory with cognitive dissonance theory. First of all, this paper adds and extends previous research (e.g. De Groot et al., 2013; Lorenzoni et al., 2007; Verplanken & Holland, 2002; Whitfield et al., 2009) on how values can affect judgements. The current research used an experimental design to show that providing information on a topic can influence judgements given that the information is in line with important underlying values. That is, providing information on the environmental benefits of reduced street lighting can motivate individuals with strong pro-environmental values to perceive lower lighting levels as more acceptable and higher lighting levels as less acceptable. Following from this, the current research examined for the first time whether individuals will downplay negative consequences of reduced street lighting which are not in line with their value driven views. Our results yielded some promising results; yet further research is needed to conclude with certainty whether individuals with strong biospheric values are motivated to align a favourable attitude towards low street lighting levels with a more favourable judgement of perceived social safety for low street lighting levels.

Second of all, as was discussed in the introduction of this paper, various studies showed that perceived social safety given specific lighting levels depends on the design of the built environment (Blöbaum & Hunecke, 2005; Boomsma & Steg, in press; Fisher & Nasar, 1992). Specifically, individuals feel safer in a low lighting setting when they perceive they can easily escape in case of danger (Boomsma & Steg, in press). This in turn can increase acceptability of reduced lighting levels. The current study suggest there is another route to promoting acceptability, by stressing possible positive environmental effects of reduced street lighting, which particularly affect acceptability judgements of those who value the environment. This in turn may affect perceived social safety of reduced lighting levels. By combining these results of previous studies with the current findings there is now support for two possible ways to increase acceptability of reduced street lighting. First, by taking *building and street design* into account. For example, by lowering street lighting in settings where the built environment

allows for safeguarding feelings of safety (e.g. low entrapment). This enables reductions in street lighting without affecting perceived social safety. Second, by targeting *individual factors*. This involves increasing awareness of value-congruent benefits of reduced street lighting, which may weaken the relative effect of negative consequences of reduced street lighting (e.g. a potential reduction in perceived social safety) on acceptability, particularly if the awareness campaign targets issues that are strongly valued by individuals. We expect that the latter may even have positive effects on perceived social safety, via a process of motivated cognition.

In conclusion, these are two different approaches that both can help in finding opportunities to reduce street lighting levels while safeguarding perceived social safety and boosting public acceptability. This is crucial since public support is needed to ensure that the desired economic savings and reductions in environmental impact can be made. However, one important point needs to be noted in this context. As may be recalled from the start of this paper – street lighting can help towards achieving actual safety. Although the current research focused on safeguarding perceived social safety when reducing street lighting levels, this does not suggest that the effect of street lighting on actual safety should be ignored. The effect of reducing street lighting levels on actual safety in a specific context should always be considered as well, making street lighting policy an interdisciplinary task.

From an applied point of view the results of the current study suggest that attempts aimed at reducing street lighting levels in a specific area should provide residents in this area with information on the benefits of reduced street lighting. Moreover, particularly value-congruent information is thought to be effective; thus, if the target group has strong biospheric values information on the environmental impact of street lighting is most likely to be effective. However, if the target group strongly values monetary savings a different focus might be advisable. For example, information could focus on the potential economic savings related to reduced street lighting. Thus, we suggest taking a tailored information approach. This comes with an important question for future research: how can different groups be identified in the field, especially when attempting to address a large population? Alternatively, a message could provide information congruent with biospheric, egoistic and altruistic values, e.g. by informing the public how reduced street lighting can help the environment and lead to monetary savings that benefit future generations. Future research should examine whether such mixed messages targeting different values are indeed effective, or whether providing information that does not resonate with one's important values may be counter effective and reduce the credibility of any value-congruent arguments provided. Finally, studies suggest that many people do value the environment (see Steg & De Groot, 2012, for a review), but may not act upon their values when these values are not activated in a given context (Verplanken & Holland, 2002; Verplanken, Trafimow, Khusid, Holland, & Steentjes, 2009). Hence, attempts could be made to activate biospheric values, to increase the likelihood that people act upon these values. Future research should study which cues are most effective in activating biospheric values, and whether this approach indeed increases the likelihood of value-congruent actions, such as enhancing the acceptability of reduced lighting policies.

We expect that the relationship between information, values and judgements translates to other values and domains: value-congruent information can increase acceptability for environmental policies, which in turn may lead individuals to downplay potential negative consequences of these policies that are not in line with value-driven views. Future research is needed to test whether this is indeed the case.

An additional interesting finding of the current study, which could be examined further, relates to the acceptability ratings for each lighting level. Overall, the data suggest that the difference between each lighting level in terms of acceptability decreased as lighting levels increased. In general, higher lighting levels tended to be rated similarly on acceptability. Consequently, there seems to be a point where acceptability ratings are not influenced strongly by lighting levels anymore. It is important to note here that movie-clips were shown to participants in a random order. Hence, it is not likely that ratings were influenced by the order in which the movie-clips were shown. This makes our results even more compelling.

4.3. Conclusion

In conclusion, acceptability of reduced street lighting policies can be increased by providing individuals with information on the environmental impact of street lighting. Importantly, this effect depends on whether the information is inline with important individual values. The information will particularly affect acceptability judgements of individuals with strong biospheric values who more strongly care about the quality of nature and the environment. In addition, as expected, it seems that individuals are motivated to avoid conflicts in cognitions; but further research is needed to find further support for the finding that individuals are motivated to downplay effects of reduced street lighting on perceived social safety if environmental benefits are of particular importance to them. In sum, information on environmental benefits that is congruent with one's biospheric values can help in making reduced street lighting levels more acceptable.

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