Is It a Bright Idea?

The Influence of Energy Efficiency Investments on Curtailment Behavior

1. **Introduction**

One day or another, at some point in time, the appliances people have at home will break down. When buying new appliances, people are confronted with different options varying in price and energy efficiency. After careful consideration some people may decide to buy the most energy-efficient appliance. An important question is how people’s behavior changes after purchasing an energy-efficient appliance. Do people start using the new appliance more or less often than before? Does it matter whether people bought it with environmental or financial considerations in mind? And finally, do people change their behavior in the same way if, for example, a landlord decides to invest in energy-efficient appliances in the rental apartment they live in?

Research on energy efficiency has shown that both investments in more energy efficient appliances and changes in day-to-day behavior are necessary to decrease the negative impact individuals have on the environment (Dietz, Gardner, Gilligan, Stern, & Vandenbergh, 2009). These two categories are often referred to as investment behavior (e.g., buying energy-efficient light bulbs or investing in solar panels) and curtailment behavior (e.g., switching lights off; Karlin et al., 2014). Although energy efficiency investments usually have a larger impact than curtailment actions (Attari, DeKay, Davidson, & Bruine de Bruin, 2010), individual’s curtailment behavior still plays an important role. As such, people have to decide whether they want to make the investment in the first place. Moreover, when people invest in energy-efficient appliances, the way they use such appliances after the investment influences the projected savings in energy consumption (Tetlow, van Dronkelaar, Beaman, Elmualim, & Couling, 2015). In other words, when people simply adopt new technologies but do not use them properly (e.g., purchasing efficient appliances but then using them more often), the anticipated positive impact on the environment tends to be smaller than projected.

Even though some studies have investigated the specific effectiveness of energy efficiency investments (e.g., Fowlie, Greenstone, & Wolfram, 2018), the behavioral implications of such investments are often overlooked. In reality, both behaviors occur concurrently and are likely to influence one another. This research aims to study the effect of investments on subsequent curtailment behavior and test whether this depends on the way the investment is framed (i.e., environmental or financial framing) and by whom the investment is made (i.e., by the consumer or someone else).

* 1. **Curtailment after investment**

Research on the relation between investment and curtailment behavior has been relatively limited (Garvey & Bolton, 2017), with a few exceptions. Correlational research by Jansson, Marell, and Nordlund (2010) showed that people were less likely to engage in curtailment behavior when they had already invested in an ‘eco-innovation’ (i.e., an alternative fuel vehicle). As this study was correlational in nature, the direction of the effect is unclear. McCoy and Lyons (2017) tackled the causality issue and found that curtailment behavior had a negative effect on investment behavior. Unfortunately, these studies do not give a clear direction on the potential impact of an investment on day-to-day curtailment behavior. However, the broader topic of how changes in one behavior impact other behaviors has been extensively studied and is often referred to as spillover (Thøgersen & Crompton, 2009). *Negative spillover* (e.g., "rebound effects" or "licensing") occurs when people first engage in an environmentally-friendly behavior and then engage *less* in subsequent pro-environmental behaviors, whereas *positive spillover* (e.g., "consistency effects" or "foot-in-the-door") occurs when people engage *more* in subsequent pro-environmental actions. Even though studies on spillover usually concern curtailment behavior in different pro-environmental domains, the principles that have been studied may apply to the interaction between investment and curtailment behaviors in a similar fashion, as we discuss below.

* 1. **Environmental versus financial framing**

Decisions to purchase energy-efficient appliances can be guided by many different considerations (e.g., the look of the appliance, price, energy efficiency, social norms, etc.). As people have to spend money when investing in energy-efficient appliances, the potential monetary benefits are often highlighted. Even though financial appeals have been effective when targeting investments alone (e.g., Bolderdijk & Steg, 2015; Handgraaf, Griffioen, Bolderdijk, & Thøgersen, 2017), environmental appeals have been more effective in stimulating curtailment behavior (e.g., Schwartz, Bruine de Bruin, Fischhoff, & Lave, 2015). Moreover, research on the effectiveness of environmental and financial appeals on spillover actually shows that environmental appeals can be rather effective in terms of *positive* spillover to recycling (Evans et al., 2013) and climate-friendly intentions (Steinhorst, Klöckner, & Matthies, 2015).

* + 1. **Self-identity perspective**

Whether positive or negative spillover is more likely to occur has been closely linked to how people perceive the initial pro-environmental act and whether it is aligned with their self-identity (Meijers, Noordewier, & Avramova, 2013; Mullen & Monin, 2016). In line with Bem’s self-perception theory (1967), people deduce from their previous behavior what kind of person they are and this influences their subsequent behavior. Therefore, irrespective of the type of message, as long as the initial behavior is in line with someone’s identity, a positive effect on related pro-environmental behaviors can be expected (Garvey & Bolton, 2017; van den Broek, Bolderdijk, & Steg, 2017). When people act purely for financial gain, people may not feel as good about it, as they do not want to come across as a ‘cheapskate’ (Bolderdijk, Steg, Geller, Lehman, & Postmes, 2013), which implies that the financial frame might be less related to someone’s self-identity.

* + 1. **Licensing**

In contrast to the self-identity approach, licensing theory predicts that negative spillover is more likely to occur. Licensing is conceptually similar to negative spillover, as it poses that people will act less morally after they have done something moral (e.g., Blanken, van de Ven, & Zeelenberg, 2015). Whether someone perceives the behavior to be moral may depend on how it is framed, as pro-environmental behavior can be framed as something pro-environmental (which is arguably a moral act) or something more rational and less moral (by focusing on the financial benefits of the behavior; Bolderdijk, Steg, Geller, Lehman, & Postmes, 2013). This would suggest that licensing behavior may be more pronounced among people who have invested for environmental reasons as opposed to financial reasons, since the former may be perceived as more moral.

* 1. **Self vs. other investment**

Most research focuses on investments made by people themselves, whereas there are many situations (e.g., at work or a hotel) in which people do not necessarily control what kind of appliances they use or how well a building is insulated. Across all these situations, the energy-saving potential of energy-efficient measures depends on individual users and their behavior may also be affected by investments made by others. Additionally, people often do not pay for the energy they use in these situations and focusing on the environmental or financial benefits of saving energy may thus have different effects.

Research on social norms suggests that investments made by others may send out a normative signal in terms of the desirable or appropriate thing to do (e.g., Cialdini, Kallgren, & Reno, 1991). Therefore, if people indeed perceive the investment made by someone else in a normative manner, investments made for environmental reasons may prove to be especially effective. When someone else does something positive for the environment may signal the social norm that the right thing to do is to act in a pro-social, pro-environmental manner. This is in contrast to the social norm associated with investments for financial reasons. Possibly, when someone invests to only derive personal benefits from the investment, this may signal that it is appropriate to act in a self-enhancing manner. Particularly, when people do not invest in an energy-efficient appliance themselves and also do not pay for the electricity this new appliance uses, it may feel very costly (e.g., in terms of effort, time, or comfort) to engage in energy-saving behavior. Therefore, when someone else invests for financial purposes, a self-enhancing norm can be evoked which would prescribe that the individual end-user of energy is allowed to act in a more self-enhancing manner (e.g., more comfort and time). In other words, we expect that negative spillover is more likely to occur. For example, if a landlord installs efficient lights, the tenants may see this as self-interested, and therefore feel entitled to leave the lights on longer.

Alternatively, purely from a licensing perspective, when someone else makes an investment, an individual has not done anything moral, suggesting that licensing is unlikely to occur. Therefore, from a licensing perspective we would expect that nothing would happen to someone’s curtailment behavior after someone else has made an investment.

* 1. **The current research**

In the current study we want to investigate how energy-efficiency investments affect subsequent curtailment behavior. We address this issue by studying actual energy use behavior in a lab experiment and focusing on the effect of an investment in a more efficient light bulb on subsequent curtailment behavior (i.e., turning the light off). We manipulate two factors: who makes the investment (self vs. other) and how this investment is framed (environmental vs. financial). In terms of curtailment behavior after an investment is made, we test two competing theories that predict opposite effects in terms of positive versus negative spillover behavior. From a social norms and self-identity perspective, irrespective of who invests, we expect a positive effect on curtailment behavior when environmental benefits are highlighted. Highlighting the financial benefits will likely not result in any spillover when participants have invested themselves, whereas we expect negative spillover when investments are made by others. As argued above, a financial frame will signal a self-enhancing norm, which would suggest that people will likely act in a more self-enhancing manner and thus not conserve energy for the benefit of someone else (as they do not benefit from lower energy expenses). In Table 1 we have summarized our expectations.

Table 1

*Expected effects on curtailment behavior after investment is made, from a social norms and self-identity perspective*

|  |  |  |
| --- | --- | --- |
|  | Environmental frame | Financial frame |
| Investment made by self | a large positive effect | no effect |
| Investment made by others | a large positive effect | a large negative effect |

From a licensing perspective we expect rather different effects of the investment on curtailment behavior. We only expect an effect when participants have made the investment themselves: A negative effect, which we expect to be most pronounced in the environmental frame. Specifically, when people do something for environmental reasons, they are expected to accumulate more credits (or credentials) which they can use to act less morally on subsequent curtailment behavior. Table 2 shows our expectations from a licensing perspective (in terms of curtailment behavior after an investment is made).

Table 2

*Expected effects on curtailment behavior after investment is made, from a licensing perspective*

|  |  |  |
| --- | --- | --- |
|  | Environmental frame | Financial frame |
| Investment made by self | negative effect | a small negative effect |
| Investment made by others | no effect | no effect |

1. **Materials and Methods**

**Participants and design.** 200 Students from a large North American university participated in this study either in exchange for course credit or for 11 CAD. 2 Participants were excluded from the analysis (due to fire alarm issues and an error in providing the manipulations), which left us with a final sample of 198 participants (57% female, *Mage* = 20.34, *SDage* = 3.96)*.* Participants were randomly assigned to conditions in a 2(Investment: self vs. other) × 2(Message: environmental vs. financial) between-subjects design.

**Procedure and Measures.**

*Overview.* The general procedure of the experiment is depicted in Figure 1; participants were first asked to complete a round of 5 irrelevant tasks, were then randomly assigned to one of the four manipulations and an investment in a more energy-efficient LED light bulb was made, and then they completed another round of 5 irrelevant tasks. After completing each task, we measured whether participants switched the desk lamp off in the room they completed the task in. Finally, participants were asked to complete a survey on a computer, and we measured whether they switched the main light off after completing the survey.

* Paste Figure 1 about here —

*First round of tasks.* While sitting in the main room, a researcher provided the instructions for the experiment (see Appendices 1 and 2 for the set-up of the laboratory, instructions and tasks). Participants were explicitly asked to complete the tasks as fast as they could in the assigned room. These tasks were irrelevant to the investment and the curtailment behaviors (e.g., solving math problems). All four rooms had a desk lamp with an incandescent light bulb, which participants used to complete the tasks. The desk lamp was always switched off at the beginning of each session and participants thus had to switch the lamp on (and off) themselves. Upon completing the first task, the participant was instructed to go back into the main room, returned the completed task to the researcher and was handed the second task and was instructed to complete the next task in another room. This procedure was repeated five times. During the tasks we measured time in the room, whether participants switched the desk lamp off at the end of the task, and how they performed. After the fifth task, participants were asked to sit down again and complete an unrelated 3-minute survey. After completing this unrelated survey, participants returned to the tasks in the different rooms.

*Manipulation.* At this point, participants were randomly assigned to the 2×2 design, consisting of four separate manipulation texts (see Appendix 3). Participants were either asked to change the incandescent light bulb in the desk lamp for energy-efficient LED light bulb themselves (which they could also refuse to do) or were told that the researcher would change the light bulbs for them. Moreover, participants were told that the light bulb in the desk lamp was changed for either environmental or financial reasons.

*Second round of tasks.* After the light bulbs had been changed (either by participants themselves or the researcher[[1]](#footnote-1)), participants were asked to complete five similar tasks following the procedure from Round 1. Participants were randomly assigned to start with either the first set of tasks or the second set of tasks. The reason we used five rounds of tasks was to simulate the repetitive nature of curtailment behavior in daily life (e.g., turning off lights multiple times a day when leaving rooms).

After completing the last five rounds of tasks, participants were asked to sit down again in the main room and completed another part of the unrelated study. Thereafter, participants were asked to go into the final room in which they were asked to complete a survey on the computer. The researcher walked together with the participant into the room, switched the light on, and provided instructions for the online questionnaire.

*Survey.* Unless otherwise indicated participants were asked to score the items on a 7-point Likert scale (1 = *strongly disagree,* 7 = *strongly agree*); all scale means and standard deviations are reported in Table 3. To investigate whether individual differences in values might moderate the effects, participants were first asked to fill out the four subscales for biospheric, altruistic, egoistic, and hedonic values from Schwartz's (1992) value scale on a 9-point importance scale (−1 = *opposed to my principles,* 0 = *not important,* 7 = *extremely important*; see de Groot & Steg, 2008; Steg, Perlaviciute, van der Werff, & Lurvink, 2014). Thereafter, to measure whether participants viewed themselves as being more environmental, we asked them to fill out the environmental self-identity scale (van der Werff, Steg, & Keizer, 2014). Participants were then asked to fill out a number of questions on their current energy use, to account for baseline differences in energy use behavior at home (e.g., “I always switch the light off when I leave a room”) on a 7-point frequency scale (1 = *never,* 7 = *always*). In order to test whether the need for consistency influenced curtailment behavior after an investment, we also asked participants to fill out the Preference For Consistency Scale (e.g., "I get uncomfortable when I find my behavior contradicts my beliefs"; Cialdini, Trost, & Newsom, 1995). As a manipulation check, we asked participants “What was the main reason for changing the light bulbs?” which they could answer with “Environment,” “Financial expenses,” or “Don’t know.” We asked participants specific questions about the tasks they had just completed (e.g., “I finished the tasks as fast as I could,” “I enjoyed completing the tasks”). we asked about the magnitude of the environmental and financial impact of their light use and how much participants liked the LED and incandescent light bulbs. Finally, participants were asked for demographic information (i.e., age, gender, nationality, political orientation and study program).

*Light off end of session.* After completing the survey on the computer, participants were told that they could come back out to the main room, in which they were asked to complete the final task for the unrelated study. We recorded whether participants switched the main light off when leaving the room they completed the survey in (note: the main light was different from the desk lamp that was manipulated earlier). Participants were thanked for their participation and at the end of the semester, participants were debriefed via email.

Table 3

*Means and standard deviations of the self-report individual difference measures*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Number of items | Mean | SD | Cronbach’s α |
| Values |  |  |  |  |
| Biospheric | 4 | 5.13 | 1.19 | .79 |
| Altruistic | 4 | 5.66 | 0.97 | .63 |
| Egoistic | 5 | 4.50 | 1.15 | .69 |
| Hedonic | 3 | 5.70 | 1.04 | .70 |
|  |  |  |  |  |
| Environmental self-identity | 3 | 5.05 | 1.03 | .93 |
| Energy behavior | 15 | 3.95 | 0.80 | .71 |
| Consistency | 7 | 4.29 | 1.00 | .85 |

1. **Results**
   1. **Manipulation checks**

As a manipulation check of who changed the light bulbs, we found that participants in the self condition thought it was more their own choice (*M* = 5.68, *SD* = 1.72) than participants in the other condition (*M* = 1.97, *SD* = 1.34; *F*(1,194) = 284.42, *p* < .001, η*p*2 = .594). Additionally, we asked participants what the main reason was for replacing the light bulbs (see Table 4). We performed a three-way loglinear regression and found a significant effect of message in both the self (χ2(1) = 5.42, *p* = .030) and the other conditions (χ2(1) = 29.83, *p* < .001), indicating that participants were more likely to indicate the correct reason for changing the light bulb in both the environmental and financial message condition[[2]](#footnote-2).

Table 4

*Frequency table of main reason for why participants changed the light bulbs*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Money | |  | Environment | |
|  | Self | Other |  | Self | Other |
| Environment | 32 | 18 |  | 39 | 40 |
| Financial | 13 | 27 |  | 4 | 2 |
| Don’t know | 4 | 5 |  | 7 | 7 |

* 1. **Curtailment behavior**

***Switching desk lamp off after tasks.*** As an explicit measure of curtailment behavior after an investment was made, we measured how likely participants were to switch the lamp off in the second round of tasks as compared to the first round of tasks after the light bulbs had been replaced. The percentage of participants who switched the desk lamp off at the end of each task is depicted in Figure 2. We performed a binary logistic mixed models analysis of the relationship between the investment and message manipulations on switching the lamp off after each of the 10 tasks (0 = not off, 1 = off). In the analysis we included dummies for investment (self vs. other), message type (money vs. environment), round (Round 1 vs. Round 2) and the interaction between these variables. Additionally, we included a variable for task number to control for potential time trends.

Participants in the environmental message condition were more likely to switch the desk lamp off in the second round when they replaced the light bulb themselves (odds = 3.82, *z* = 2.33, *p* = .020), but less likely than participants in the other condition (i.e., researcher replaced the light bulb; *z* = −2.40, *p* = .016), who were even more likely to switch the lamp off in the second round (odds = 23.57, *z* = 4.18, *p* < .001). Participants in the financial message condition were not more likely to switch the lamp off in the second round when they replaced the light bulbs themselves (odds = 1.04, *z* = 1.10, *p* = .273). Excluding those who refused the change the light bulbs, we found that participants in the “Self-Money” condition were more likely to switch the light off in the second round as compared to the first round (odds = 4.10, *z* = 2.40, *p* = .017). Moreover, participants who had replaced the light bulbs themselves were more likely to switch the lamp off in the second round when reading environmental information as compared to reading the financial message (odds = 2.66, *z* = 1.65, *p* = .098). These results are in line with our hypothesis from a social norms and self-identity perspective. Contrary to our hypotheses from both a social norms and licensing perspective, we found that when the researcher replaced the light bulbs, participants in the financial message condition were more likely to switch the light off in the second round (odds = 5.25, *z* = 2.84, *p* = .005).

* Paste Figure 2 about here —

To rule out any alternate explanations for switching off behavior, we analyzed whether our conditions had an effect on time and performance (reported in Appendix 4). We found no significant effects of our manipulations, and only found that participants were faster in completing the tasks in the second round.

***Main room light off at end of session.*** As a more implicit measure of curtailment behavior, we measured whether participants switched the main room light off at the end of the experimental session. We performed a binary logistic regression, while controlling for how often participants on average switched the desk lamp off during the first five rounds of tasks (as a measure of baseline behavior). Figure 3 shows the percentage of participants per condition who switched the main room light off at the end of the session.

* Paste Figure 3 about here —

In line with our hypothesis from a social norms and self-identity perspective, participants in the “Other-Money” condition were the least likely to switch the light off at the end of the session. In Table 5 we have reported the odds ratios between the four conditions with confidence intervals. Based on these odds ratios, we found that participants in the “Self-Money” condition were significantly more likely to switch the light off at the end of the session as compared to participants in the “Other-Money” condition. Similarly, compared to the “Other-Money” condition, participants in the “Self-Environment” condition were marginally significantly more likely to switch the light off (see Table A5.1 in Appendix 5). In contrast, participants in the “Other-Environment” condition were directionally but not significantly more likely to switch the light off as compared to those in the “Other-Money” condition. Apart from the “Other-Money” condition, the remaining conditions did not significantly differ from one another. Finally, examining individual differences, participants who always switched the light off during the first round of tasks were 10.18 times (95% CI [2.79, 54.09]) more likely to switch the light off at the end of the session[[3]](#footnote-3).

Table 5

*Odds of switching the main light off at the end of the session as compared to the other conditions, while controlling for “baseline” lamp switching off behavior*

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Other-Environment | |  | Other-Money | |  | Self-Environment | |
|  | Odds | 95% CI |  | Odds | 95% CI |  | Odds | 95% CI |
| Other-Money | 0.45 | 0.15-1.27 |  |  |  |  |  |  |
| Self-Environment | 1.16 | 0.46-2.98 |  | 2.59 | 0.94-7.67 |  |  |  |
| Self-Money | 1.34 | 0.53-3.44 |  | 3.00 | 1.10-8.86 |  | 1.16 | 0.47-2.87 |

*Note.* CI = Confidence Interval. An odds ratio of 1 indicates that participants in both conditions are equally likely to switch the light off (i.e., CIs including 1 are not significant).

* 1. **Self-report measures**

We performed analyses of variance (ANOVA) to test the effect of our 2×2 design on the self-report measures and report the significant effects below (see Appendix 6 for the other self-report measures). We were interested in whether our manipulations affected participants’ environmental self-identity. Our results indicated that those who had replaced the light bulbs themselves (*M* = 5.19, *SD* = 0.96) scored marginally significantly higher than participants who did not replace the light bulbs themselves (*M* = 4.90, *SD* = 1.08; *F*(1,194) = 3.81, *p* = .052, η*p*2 = .019). Excluding the participants who refused to change the light bulbs, we found that participants who had replaced the light bulbs themselves (as opposed to the researcher replacing the light bulbs) scored significantly higher on environmental self-identity (*F*(1,184) = 4.26, *p* = .040, η*p*2 = .023). We did not find a significant effect of message on environmental self-identity (*F*(1,194) = 0.04, *p* = .852, η*p*2 = .852) nor an interaction between who invested and message type (*F*(1,194) = 0.02, *p* = .904, η*p*2 = .904).

Moreover, how much participants liked the different light bulbs was influenced by whether they changed the lights themselves or not. Particularly, participants who were in the other condition (*M* = 4.45, *SD* = 1.79) liked the incandescent light bulbs more than those who replaced the light bulbs themselves (*M* = 3.57, *SD* = 1.71; *F*(1,193) = 12.59, *p* < .001, η*p*2 = .061). In contrast, participants who replaced the light bulbs themselves indicated to like the LED lights better (*M* = 5.05, *SD* = 1.59) than those in the other condition (*M* = 4.15, *SD* = 1.91; *F*(1,194) = 13.40, *p* < .001, η*p*2 = .065). Moreover, we found a significant interaction between type of message and who replaced the light bulbs (*F*(1,194) = 8.35, *p* = .004, η*p*2 = .041). This interaction indicated that only those in the money condition portrayed a difference in liking of the LED light: Participants who replaced the light bulb themselves (*M* = 5.34, *SD* = 1.47) liked the light bulb significantly better as compared to those who let the researcher replace the light bulbs (*M* = 3.76, *SD* = 1.80). Besides the liking of the light bulbs, we also found that participants in the money condition thought the financial impact of switching lights off (*M* = 5.38, *SD* = 1.29) was significantly higher than those in the environmental condition (*M* = 4.99, *SD* = 1.50; *F*(1,194) = 3.97, *p* = .048, η*p*2 = .020).

1. **Discussion**
   1. **Implications of findings**

At the start of this research we posed two competing accounts with hypotheses regarding curtailment behavior after an investment in a more energy-efficient appliance was made. In our experiment we could differentiate between curtailment behavior right after the investment (i.e., switching desk lamps off in the second round of tasks) and at the end of the experimental session (i.e., turning the main room light off). We will elaborate upon our findings with respect to our expectations and add additional explanations where applicable.

Our results show that the environmental message, irrespective of who had invested, had a positive effect on curtailment behavior both during the tasks and at the end of the session. The effect of the financial message appeared less straightforward, as participants who invested themselves were not more likely to switch the light off in the second round of tasks, whereas participants in the “Other”-condition were more likely to switch the light off in the second round. In terms of switching the light off at the end of the session, participants in the “Money-Other”-condition were the least inclined to switch the light off at the end of the session as compared to the other conditions. These results are mostly in line with the social norms and self-identity perspective, and not with the licensing perspective.

In contrast to our expectations from both a social norms and licensing perspective, in terms of switching the light off during the tasks, participants for whom the light bulbs were replaced by a researcher for monetary reasons were more likely to switch the lights off in the second round. We speculate that this effect may be driven by the design of the study; participants actively saw the researcher change the light bulbs, which may have evoked some feelings of reciprocity in the other condition. Besides the fact that the social norm of conserving energy may be salient, people may also feel indebted to the researcher who had just put the effort in replacing the light bulbs and reciprocate this act by switching the lights off more often in the second round. The norm of reciprocity suggests that people are more likely to comply with a request from someone who has done someone a favor in the past (Cialdini, 2001; Gouldner, 1960). Even though we did not specifically ask the participants to switch the lights off in the second round of tasks, it may have been implied by the fact that the researcher put effort in replacing all the light bulbs for the participants. Future research could address this issue by having a similar set-up in which people get a more energy-efficient appliance, but either show participants that someone else is putting effort in replacing the old appliance or simply put participants in the new situation without making them explicitly aware of the effort put into replacing the old appliance.

Alternatively, it could be that participants were simply more aware of their light use in the second round of tasks. As such, when the light bulbs were actually changed (i.e., when we ran the analyses without the participants who refused), we found that all participants were more likely to switch the light off in the second round. For this reason, we included the more implicit measure of curtailment behavior at the end of the experimental session. We argue that this measure is less prone to the awareness issue during the completion of the tasks in the different rooms. Our results showed that, on average, participants were far less likely to switch the light off at the end of the session (as compared to the prevalence of switching the lights off while they were completing the tasks). In line with our hypotheses based on social norms theory, participants for whom the researcher had replaced the light bulbs for monetary reasons (“Other-Money”-condition) were the least likely to switch the light off at the end of the session. This finding is in line with our expectations from a social norms perspective, as it may have signaled a social norm of acting in a more self-interested manner. In contrast to our expectations, we also found that participants who had replaced the light bulbs themselves for monetary reasons were more inclined to switch the light off at the end of the session. We speculate that this effect is in part driven by the way people’s self-perception may have been changed after changing the light bulbs themselves.

Specifically, we found that all participants who had replaced the light bulbs themselves viewed themselves as a more environmentally-friendly person as compared to those who had not replaced the light bulbs themselves. Interestingly, participants who replaced the light bulbs for monetary reasons also viewed themselves as an environmentally-friendly person. This was rather surprising but could be explained by the fact that participants who had replaced the light bulbs themselves for monetary reasons were also inclined to indicate that they had done this for environmental reasons. This showed that changing the light bulbs may make people think of what kind of person they are, and they may thus think that by changing the light bulbs they are actually an environmentally-friendly person (irrespective of type of message), which is not the case when someone else had replaced the light bulbs.

Additionally, we asked participants which type of light bulb they liked better (i.e., the incandescent or LED light). Remarkably, participants who had replaced the light bulbs themselves liked the LED lights better, whereas participants who had not replaced the light bulbs themselves liked the incandescent light bulbs better. Even though this was a rather simple measure of liking, this may provide some direction on how likely people are to support new innovations when they have not chosen for the measure themselves. Moreover, our finding is also in line with the so-called “IKEA effect” (Norton, Mochon, & Ariely, 2012), which suggests that people value self-assembled products more. Our study suggests that giving people the opportunity to make a choice on whether they wanted to install the light bulbs themselves (and actually installing them) was enough to increase liking of the more energy-efficient LED light bulbs.

* 1. **Limitations and future research**

Many studies on licensing behavior include a so-called donut design (Mullen & Monin, 2016), which means that research designs do not include a baseline measure which makes it harder to make any claims of positive or negative spillover. We were able to combat this issue, as we included a baseline measure of curtailment behavior in the first round of tasks and measured real behavior. We did not, however, include a pure control condition, which would be especially useful for interpreting the results with regards to the switching off behavior at the end of the session. Moreover, even though we measured behavior in an objective manner, we studied curtailment behavior after an investment was made in a highly controlled lab setting, which limits the external validity of our study. Future research would, therefore, benefit greatly from conducting a similar study in a field setting, in order to get more insights in the magnitude of the positive and negative effects on curtailment behavior after an investment in an energy-efficiency measure is made.

In our experiment, we decided to exclude any monetary investment, as it may have confounded the differences we could have found between an investment made by someone him or herself and an investment made by someone else. We, therefore, decided to operationalize the investment mostly as effort and time someone had to invest in replacing the light bulbs and not making the design overly complicated with monetary investment schemes. However, future research could study whether investing actual money in energy-efficiency measures influences behavior in a different manner. It could be that when people invest actual money, they may adopt a cost-benefit mindset (Deci, Koestner, & Ryan, 1999), and may not perceive themselves as being an environmentally-friendly person.

* 1. **Concluding remarks**

This study investigated how an investment in an energy-efficiency measure influences subsequent curtailment behavior. We measured curtailment behavior immediately after the investment was made, as well as at the end of the experiment. Our findings suggest that when someone else invests in an energy-efficiency measure it is more effective to focus on the environmental benefits and not on the monetary benefits. Even though focusing on financial reasoning may seem the most rational thing to do, it can have negative effects on individual behavior. Ultimately, in many situations people are the end-users and focusing on environmental benefits may prove to be most effective. When financial benefits must be highlighted, the best way forward would be to get people personally involved in the investment (rather than having it enacted by a third party), as this will improve their pro-environmental curtailment behavior later on.

References

Attari, S. Z., DeKay, M. L., Davidson, C. I., & Bruine de Bruin, W. (2010). Public perceptions of energy consumption and savings. *Proceedings of the National Academy of Sciences*, *107*(37), 16054–16059. https://doi.org/10.1073/pnas.1001509107

Bem, D. J. (1967). Self-perception: An alternative interpretation of cognitive dissonance phenomena. *Psychological Review*, *74*(3), 183–200.

Blanken, I., van de Ven, N., & Zeelenberg, M. (2015). A meta-analytic review of moral licensing. *Personality and Social Psychology Bulletin*, *41*(4), 540–558. https://doi.org/10.1177/0146167215572134

Bolderdijk, J. W., & Steg, L. (2015). Promoting sustainable consumption: The risks of using financial incentives. In L. A. Reisch & J. Thøgersen (Eds.), *Handbook of Research in Sustainable Consumption* (pp. 328–342). Cheltenham: Edward Elgar. https://doi.org/10.4337/9781783471270.00033

Bolderdijk, J. W., Steg, L., Geller, E. S., Lehman, P. K., & Postmes, T. (2013). Comparing the effectiveness of monetary versus moral motives in environmental campaigning. *Nature Climate Change*, *3*(4), 413–416. https://doi.org/10.1038/nclimate1767

Cialdini, R. B. (2001). Harnessing the science of persuasion. *Harvard Business Review*, 72–79.

Cialdini, R. B., Kallgren, C. A., & Reno, R. R. (1991). A focus theory of normative conduct: A theoretical refinement and reevaluation of the role of norms in human behavior. *Advances in Experimental Social Psychology*, *24*(C), 201–234. https://doi.org/10.1016/S0065-2601(08)60330-5

Cialdini, R. B., Trost, M. R., & Newsom, J. T. (1995). Preference for consistency: The development of a valid measure and the discovery of surprising behavioral implications. *Journal of Personality and Social Psychology*, *69*(2), 318–328. https://doi.org/10.1037/0022-3514.69.2.318

de Groot, J. I. M., & Steg, L. (2008). Value orientations to explain beliefs related to environmental significant behavior: How to measure egoistic, altruistic, and biospheric value orientations. *Environment and Behavior*, *40*(3), 330–354. https://doi.org/10.1177/0013916506297831

Deci, E. L., Koestner, R., & Ryan, R. M. (1999). A meta-analytic review of experiments examining the effects of extrinsic rewards on intrinsic motivation. *Psychological Bulletin*, *125*(6), 627-668; discussion 692-700. https://doi.org/10.1037/0033-2909.125.6.627

Dietz, T., Gardner, G. T., Gilligan, J., Stern, P. C., & Vandenbergh, M. P. (2009). Household actions can provide a behavioral wedge to rapidly reduce US carbon emissions. *Proceedings of the National Academy of Sciences*, *106*(4), 18452–18456. https://doi.org/10.1073/pnas.0908738106

Evans, L., Maio, G. R., Corner, A., Hodgetts, C. J., Ahmed, S., & Hahn, U. (2013). Self-interest and pro-environmental behaviour. *Nature Climate Change*, *3*(2), 122–125. https://doi.org/10.1038/nclimate1662

Fowlie, M., Greenstone, M., & Wolfram, C. D. (2018). *Do energy efficiency investments deliver? Evidence from the weatherization assistance program*. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2621817

Garvey, A. M., & Bolton, L. E. (2017). Eco-product choice cuts both ways: How proenvironmental licensing versus reinforcement is contingent on environmental consciousness. *Journal of Public Policy & Marketing*, *36*(2), 284–298. https://doi.org/10.1509/jppm.16.096

Gouldner, A. W. (1960). The Norm of Reciprocity: A Preliminary Statement. *American Sociological Review*, *25*(2), 161. https://doi.org/10.2307/2092623

Handgraaf, M. J. J., Griffioen, A. M., Bolderdijk, J. W., & Thøgersen, J. (2017). Economic psychology and pro-environmental behaviour. In *Economic Psychology* (pp. 435–450). Chichester, UK: John Wiley & Sons, Ltd. https://doi.org/10.1002/9781118926352.ch27

Jansson, J., Marell, A., & Nordlund, A. (2010). Green consumer behavior: Determinants of curtailment and eco-innovation adoption. *Journal of Consumer Marketing*, *27*(5), 358–370. Retrieved from https://doi.org/10.1108/07363761011052396

Karlin, B., Davis, N., Sanguinetti, A., Gamble, K., Kirkby, D., & Stokols, D. (2014). Dimensions of conservation: Exploring differences among energy behaviors. *Environment and Behavior*, *46*(4), 423–452. https://doi.org/10.1177/0013916512467532

McCoy, D., & Lyons, S. (2017). Unintended outcomes of electricity smart-metering: trading-off consumption and investment behaviour. *Energy Efficiency*, *10*(2), 299–318. https://doi.org/10.1007/s12053-016-9452-9

Meijers, M. H. C., Noordewier, M. K., & Avramova, Y. R. (2013). I just recycled. can I use the car now? When people continue or discontinue behaving sustainably after an initial sustainable act. In *Encouraging Sustainable Behavior: Psychology and the Environment*. https://doi.org/10.4324/9780203141182

Mullen, E., & Monin, B. (2016). Consistency vs. licensing effects of past moral behavior. *Annual Review of Psychology*, *67*(1), 363–385. https://doi.org/10.1146/annurev-psych-010213-115120

Norton, M. I., Mochon, D., & Ariely, D. (2012). The IKEA effect: When labor leads to love. *Journal of Consumer Psychology*, *22*, 453–460. https://doi.org/10.1016/j.jcps.2011.08.002

Schwartz, D., Bruine de Bruin, W., Fischhoff, B., & Lave, L. (2015). Advertising energy saving programs: The potential environmental cost of emphasizing monetary savings. *Journal of Experimental Psychology. Applied*, *21*(2), 158–166. https://doi.org/10.1037/xap0000042

Schwartz, S. H. (1992). Universals in the content and structure of values: Theoretical advances and empirical tests in 20 countries. In *Advances in Experimental Social Psychology* (Vol. 25, pp. 1–65). https://doi.org/10.1016/S0065-2601(08)60281-6

Steg, L., Perlaviciute, G., van der Werff, E., & Lurvink, J. (2014). The significance of hedonic values for environmentally relevant attitudes, preferences, and actions. *Environment and Behavior*, *46*(2), 163–192. https://doi.org/10.1177/0013916512454730

Steinhorst, J., Klöckner, C. A., & Matthies, E. (2015). Saving electricity – For the money or the environment? Risks of limiting pro-environmental spillover when using monetary framing. *Journal of Environmental Psychology*, *43*, 125–135. https://doi.org/10.1016/j.jenvp.2015.05.012

Tetlow, R. M., van Dronkelaar, C., Beaman, C. P., Elmualim, A. A., & Couling, K. (2015). Identifying behavioural predictors of small power electricity consumption in office buildings. *Building and Environment*, *92*, 75–85. https://doi.org/10.1016/j.buildenv.2015.04.009

Thøgersen, J., & Crompton, T. (2009). Simple and painless? The limitations of spillover in environmental campaigning. *Journal of Consumer Policy*, *32*(2), 141–163. https://doi.org/10.1007/s10603-009-9101-1

van den Broek, K., Bolderdijk, J. W., & Steg, L. (2017). Individual differences in values determine the relative persuasiveness of biospheric, economic and combined appeals. *Journal of Environmental Psychology*, *53*, 145–156. https://doi.org/10.1016/J.JENVP.2017.07.009

van der Werff, E., Steg, L., & Keizer, K. (2014). I am what I am, by looking past the present: The influence of biospheric values and past behavior on environmental self-identity. *Environment and Behavior*, *46*(5), 626–657. https://doi.org/10.1177/0013916512475209

1. The 10 participants who refused to change the light bulbs (and thus kept the incandescent bulbs for Round 2) are included in all analyses. We also ran the analyses without these participants and our results were qualitatively the same. In case we did find differences, we reported those differences in a footnote. [↑](#footnote-ref-1)
2. Despite this significant effect, the accuracy of participants in the financial message condition was rather low, which we attribute to the vague wording of the question. As such, it was not a pure recall-question, but rather a general question asking participants for the main reason for changing the light bulbs. This could have been interpreted as their own main reason and not necessarily the given reason in the experiment. [↑](#footnote-ref-2)
3. As environmental concern may also play a role in how likely participants were to switch the main light off at the end, we ran the same analysis while controlling for biospheric values. Including biospheric values in the analysis did not alter the results and biospheric values did not have a significant effect on switching off behavior at the end of the session (both at 90% and 95% confidence interval). [↑](#footnote-ref-3)