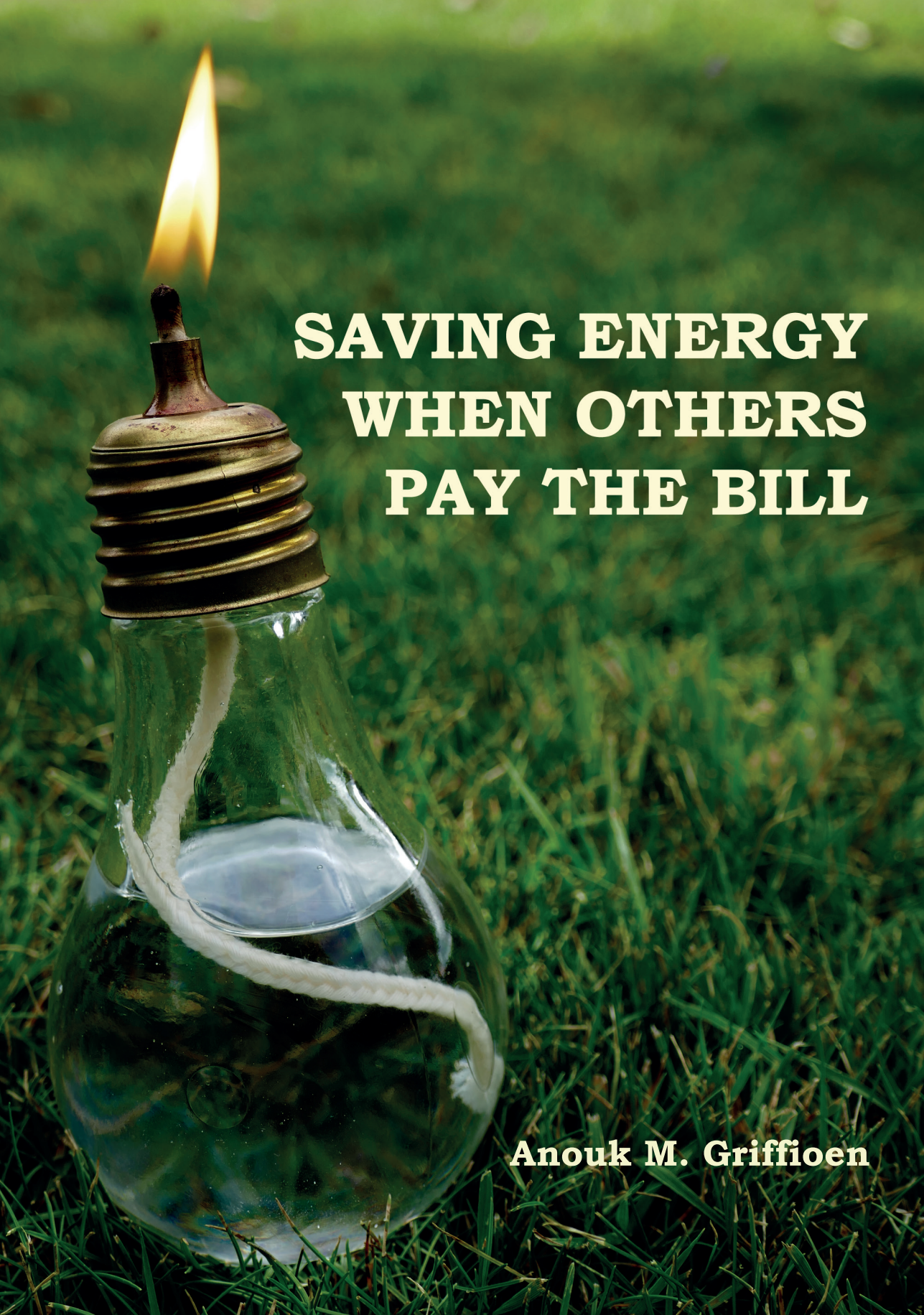

SAVING ENERGY WHEN OTHERS PAY THE BILL

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Saving Energy When Others Pay the Bill

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Saving Energy When Others Pay the Bill

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Chapter 1

General introduction

1.1 Introduction

Human behavior has been a critical contributor to CO_2 emissions and environmental degradation in general. Despite the fact that technology is advancing rapidly and can help to reduce the impact humans have on the environment, people need to consider how they can change their individual behavior to decrease their environmental impact (Dietz, Gardner, Gilligan, Stern, & Vandenbergh, 2009). Individual energy use contributes to total CO_2 emissions and accounts for approximately 40% of total final energy use in both the US and the EU (EIA, 2018; Eurostat, 2018). Not only does individual behavior impact energy use within households, individuals also have an impact on energy use in situations outside of their home, such as at work, school or in public buildings. Although individual energy use within and outside the home is similar in magnitude, previous studies and interventions have primarily focused on stimulating household energy conservation behavior (Abrahamse, Steg, Vlek, & Rothengatter, 2005; Frederiks, Stenner, & Hobman, 2015a). Even though some findings from the household situation could be translated and applied to out-of-home situations, there are some clear differences. As such, in out-of-home situations people do not have clear control over what kind of energy-efficient appliances there are in place, nor do they always pay for the energy they use. In reference to the latter difference, it remains largely unclear how interventions would play out when people do not pay for the energy they use and thus not personally benefit from changing their behavior (Schultz, Nolan, Cialdini, Goldstein, & Griskevicius, 2007).These fundamental differences, combined with the high amount of energy used in out-of-home situations, make it important to understand the drivers of individual energy use behavior in situations other than the household.

The aim of this dissertation is to study how different intervention approaches function when people do not personally benefit from changing their behavior (i.e., when others pay the bill) and systematically test which intervention approaches work best across different situations (e.g., hotel or rental apartment). Motivating individuals to reduce their energy use and thereby reducing their negative impact on the environment has proven to be a challenge. This is in part fueled by the fact that acting in a pro-environmental, sustainable manner often involves foregoing some immediate benefits (e.g., time, comfort) in order to minimize one's negative impact on the environment in the long run. Moreover, in order to have a positive impact on the environment, it is important to not only focus on one single behavior or choice. Instead of focusing on one behavior, the net impact of interventions should be taken into account, which means that the long-term effects and effects on energy-related

behaviors should be considered. To classify different intervention approaches and capture the challenges of energy use behavior in general, we use construal level theory as a general framework. Based on construal level theory (Liberman & Trope, 1998) some intervention approaches can be classified as more concrete, low construal level approaches, whereas other approaches fall into the abstract, high construal level category. Construal level theory poses that the way people process information, objects or events depends on the level of abstraction, and manipulating the construal level of different intervention approaches allows us to test what kind of approach is best suited for stimulating energy saving behavior in out-of-home situations. We are specifically interested in the net impact of construal level manipulations, which means that we are interested in the effect of (the combination of) construal level manipulations on a target behavior, in both the short and long run, as well as the effects on other energy-related behaviors. Across a number of laboratory and field studies, we have studied different combinations of intervention approaches and message appeals in terms of its effects on objectively measured energy use behavior. In this chapter we will introduce the literature that forms the basis for the four subsequent empirical chapters.

1.2 Determinants of energy use behavior

To understand how energy use behavior can be changed, it is important to understand the underlying factors that determine how much energy people currently use. First and foremost, the amount of energy people use across different situations is largely determined by the structural characteristics of a building. As such, Wilson and Dowlatabadi (2007) argue that much of residential energy use is determined by housing characteristics (e.g., size, location). Beyond these structural factors that determine how much energy people use, individuals' behaviors and decisions also influence the total energy use across different situations. Unfortunately, not everyone is motivated to actually care about the amount of energy they use. In addition, those who do want to minimize their total energy use often still find it difficult to attain this goal. The fact that energy saving behavior is difficult to achieve can in part be explained by the experience of a conflict between short-term individual benefits and long-term collective benefits (Handgraaf, Griffioen, Bolderdijk, & Thøgersen, 2017; Steg & de Groot, 2012). For example, when someone wants to reduce their water use at home, one thing this person could do is to take shorter and colder showers. The long-term benefits of this behavior are a reduction in total energy use, but people directly experience the colder and shorter shower and thus forego the immediate enjoyment of a long, hot shower. Despite this conflict of interest, some people are still

willing to act in a pro-environmental manner and thus minimize their total energy use, which has been suggested to be driven by a certain degree of care for the (well-being of the) environment in itself (Steg & de Groot, 2012).

How much people care for and value the environment is often measured by a construct called biospheric values (Steg & de Groot, 2012). Biospheric values refer to the extent to which people care for the environment and the preservation thereof. Biospheric values have been pinpointed as an important and stable underlying factor for energy use behavior and pro-environmental behavior in general (de Groot & Steg, 2008; Nilsson, Von Borgstede, & Biel, 2004). According to Schwartz (1992) "[v]alues (1) are concepts or beliefs, (2) pertain to desirable end states or behaviors, (3) transcend specific situations, (4) guide selection or evaluation of behavior or events, and (5) are ordered by relative importance" (p. 4). Even though some studies have found a positive correlation between biospheric values and pro-environmental behavior, other studies have failed to find this direct relationship (see Frederiks et al., 2015; Wilson & Dowlatabadi, 2007). Different plausible explanations exist for why the link between these general values and specific behavior is sometimes rather weak.

First of all, people do not always act upon their inner values and (more immediate) situational influences sometimes have a greater impact on the way people behave in particular situations. Secondly, the way behavior is measured may influence the effect of other (contextual) factors on behavior (see Frederiks et al., 2015b; Gifford & Nilsson, 2014; Steg & Vlek, 2009; Wilson & Dowlatabadi, 2007). As such, when intentions are measured one is likely to find a rather high positive correlation with biospheric values, as intentions are unaffected by other contextual characteristics. However, when objective measures of behavior are taken, other contextual factors (e.g., housing characteristics) may play a bigger role and the correlation with biospheric values can be expected to be much lower. Part of this discrepancy between intentions and actual behavior can be ascribed to the so-called "intention-behavior" gap – similar to a "knowledge-behavior" gap or "attitude-behavior" gap – which posits that intentions will not directly translate into behavior (Kollmuss & Agyeman, 2002). Thirdly, and finally, Klöckner (2013) argues that the complexities of pro-environmental behavior also account for the sometimes weak link between biospheric values and behavior. Specifically, he argues that "[e]nvironmental behavior can ultimately be traced back to basic value orientations, even if the distance between such values and behavior is bridged by a long line of mediating variables" (p. 1035). As values do seem to be at the core of environmental behavior, it is important to study such values, especially because values are unlikely to change over short periods of time (Bardi, Lee, Hofmann-Towfigh, & Soutar, 2009).

Even though people do not always seem to directly act upon their values, values can be made temporally salient and influence subsequent choices and behavior (Evans et al., 2013; Maio, Pakizeh, Cheung, & Rees, 2009; Verplanken & Holland, 2002). Obviously, people may value other things in life than just the environment, and by making certain features more salient can motivate people to act more upon specific values (e.g., self-enhancement values or self-transcendent values). Additionally, previous work has shown that how much people care for the environment (e.g., measured by biospheric values) also impacts the effectiveness of interventions (e.g., Bolderdijk, Gorsira, Keizer, & Steg, 2013; van den Broek, Bolderdijk, & Steg, 2017). The fact that even people who care for the environment do not always act upon these values, stresses the need for appropriate interventions to change behavior and reduce overall energy use.

1.3 How to change energy use behavior?

When targeting a change in energy use, it has been suggested that people can engage in two types of activities to reduce their energy use: investment (or efficiency) behavior and curtailment behavior (Karlin et al., 2014; Stern, 2000). As the name suggests, investment behavior involves making an investment in an energy-efficient measure or appliance. In contrast, curtailment behavior can be defined as making day-to-day changes without having to make an investment. For example, in terms of reducing energy use in the shower, an investment action would be to invest in a more efficient shower head, whereas the curtailment behavior would be to take shorter showers. Even though investment actions usually have a larger impact in terms of potential energy reduction (Attari, DeKay, Davidson, & Bruine de Bruin, 2010), curtailment behavior remains equally important as people have to use energy-efficient appliances appropriately in order to reach the projected energy savings (Tetlow, van Dronkelaar, Beaman, Elmualim, & Couling, 2015). In situations in which people do not pay for their energy use, it is unlikely or impossible for people to invest in energy efficiency measures. However, the fact that there are energy efficiency measures in place may influence subsequent curtailment behavior. For example, when staying at a hotel, the management may have decided to invest in energy efficiency measures to decrease their total energy use. In this example, it is also important to understand how such investments would affect individual behavior and whether people use particular appliances differently (i.e., more often or more sparingly) when they know that energy efficiency measures are in place. We have studied this issue in Chapter 2; where we look at the downstream consequences of an investment in a more energy efficient appliance on subsequent curtailment behavior. More specifically, we compare whether

investments made by others or by individuals themselves has the same effect on subsequent curtailment behavior. Additionally, we were interested in whether different motivations (i.e., for environmental or financial reasons) of a third party to invest in energy efficiency measures affected curtailment behavior. In this chapter we were foremost interested in the downstream effects of energy efficiency measures on curtailment behavior and did not classify this intervention along the lines of construal level. We will address this point in Chapter 6 and elaborate on how we would interpret our results from a construal level theory perspective.

As noted, in out-of-home situations, it is unlikely that people will invest in more energy-efficient measures or appliances. For example, at work, it is highly unlikely, and usually impossible, that an employee decides to invest in insulation of the office building. Therefore, as we specifically focus on out-of-home situations in this dissertation, we are particularly interested in how to change curtailment behavior. Much of the early work that focused on changing energy use behavior focused on the most straightforward approach: increasing knowledge about energy use and its impact on the environment (Kollmuss & Agyeman, 2002). Unfortunately, most research shows that simply providing people with the right information is by itself not enough to establish behavior change, even though it may change their attitudes (Abrahamse et al., 2005). After the initial focus of merely providing people with the right information, interventions used different approaches to spark behavior change. As such, in both household settings and out-of-home situations, interventions have included voluntary commitment (Baca-Motes, Brown, Gneezy, Keenan, & Nelson, 2012; Katzev & Johnson, 1983), goal setting (Loock, Staake, & Thiesse, 2013; van Houwelingen & van Raaij, 1989), feedback (Asensio & Delmas, 2015; Bittle, Valesano, & Thaler, 1979; Schultz, Estrada, Schmitt, Sokoloski, & Silva-Send, 2015; Tiefenbeck, Goette, Degen, & Tasic, 2016), comparative feedback (Allcott, 2011; Schultz et al., 2016) and rewards (Handgraaf, van Lidth de Jeude, & Appelt, 2013). Important to note is that most of these interventions did not use one intervention approach in isolation, but combined at least two approaches in one intervention, which makes it harder to disentangle the influence of each approach. Results across different studies show that some combinations of interventions turned out to be very effective, whereas other studies did not show the desired behavior change. In order to choose the best intervention strategy, review papers have tried to specify the main factors that determine the effectiveness of interventions but have been unable to make clear recommendations due to a number of (methodological) issues. Specifically, many of the earlier studies used rather small sample sizes to study energy use behavior, relied on self-report measures, lacked a clear control group, only studied short-term change,

and most studies suffered from some self-selection issues (Abrahamse et al., 2005; Asensio & Delmas, 2015; Frederiks et al., 2015b; Frederiks, Stenner, Hobman, & Fischle, 2016; Gifford & Nilsson, 2014). Moreover, the factors that have been pinpointed to affect energy use behavior are bountiful and the interactions between these factors are complex (Gifford & Nilsson, 2014) , which makes it even more difficult to design effective interventions.

On top of the complexities associated with targeting one specific energy saving behavior, another challenge when stimulating pro-environmental behavior is to not only stimulate one-off, short-term behaviors, but to have lasting impact on a target behavior and other related behaviors at the same time. Previous research has highlighted that in order to have true impact on the environment (i.e., "net environmental impact"), one should not only look at the short-term effect on a target behavior, but also take the duration of the effect into account and consider the potential impact on related pro-environmental behaviors (Truelove, Carrico, Weber, Raimi, & Vandenbergh, 2014). More specifically, with regards to the latter point, interventions may actually influence other behaviors than the targeted behavior, which is often referred to as spillover behavior (Thøgersen, 1999). This spillover can be either positive, which means that people also improve on other pro-environmental behaviors, or negative, which means that people show less other pro-environmental behaviors (Thøgersen & Crompton, 2009). Remarkably, most studies do not look beyond the specified intervention period nor do they take potential spillover effects into account. Studies that do report the long-term effects often show that the initial effects diminish over time (see Abrahamse et al., 2005; Delmas, Fischlein, & Asensio, 2013; Frederiks, Stenner, Hobman, & Fischle, 2016).

Despite these apparent complexities of energy use behavior and the interventions targeted at changing this behavior, previous work has provided some directions for designing effective interventions. First of all, previous work highlights that combinations of interventions can be more effective than single intervention approaches (Abrahamse et al., 2005). Yet, due to the lack of systematic studies on which combinations work well across different types of situations it is unclear how to design effective combinations of interventions (Dietz et al., 2009). Secondly, many factors influence energy use behavior, but a general, simple framework that could be used to study energy use behavior is lacking and should be developed (Frederiks et al., 2016). Therefore, we base the majority of this dissertation on one specific theory or framework, in order to understand the effectiveness of different intervention approaches targeted at curtailment behavior from one particular perspective.

1.4 One framework

In our view, a model or theory that is suited to explain and promote energy saving behavior must be able to incorporate three issues: The workings of combinations of intervention approaches, the net impact of an intervention and the influence of (biospheric) values. As suggested by previous work, combinations have the potential to be more effective than singular approaches. As combinations are often not systematically tested, it remains unclear how to combine different intervention approaches in order to have the largest impact on behavior (e.g., Osbaldiston & Schott, 2012). Therefore, upon choosing a framework we considered it to be important that the theory could explain how effective combinations should be formed. Moreover, for intervention approaches to be truly effective, it is important that an intervention does not only have a positive effect on a target behavior but results in a positive net overall effect, which suggests that the positive effect should be lasting and should have a positive effect on related energy-use behaviors. The third factor we deemed important to be integrated in the model is the role of values, and particularly the role of biospheric values. Previous research has indicated that biospheric values can be considered the stable core of pro-environmental behavior. However, people do not always act upon these values and some people do not highly value the environment. Therefore, the model we wanted to use in this research should be able to make predictions about the influence of values across different intervention methods.

Previous research in relation to stimulating pro-environmental behavior has made use of many different theories and models. Social psychological theories have mostly focused on individual difference factors, and such models have successfully predicted current pro-environmental intentions and behavior. Models such as the Theory of Reasoned Action (Fishbein & Ajzen, 1975) and the Theory of Planned Behavior (Ajzen, 1985) have a strong focus on subjective norms and attitudes toward behavior and its influence on intentions, which in turn influences behavior. Other models have had a stronger focus on personal norms, such as the Norm Activation Model (Schwartz, 1977) and Value Belief Norm Theory of pro-environmental behavior (Stern, Dietz, Abel, Guagnano, & Kalof, 1999), which show that various individual difference and contextual factors influence the personal norm to act in a pro-environmental manner, which in turn predicts actual pro-environmental behavior. Self-Determination Theory (Deci & Ryan, 1985) focuses on how behavior is guided by intrinsic or extrinsic motivation and studies the underlying factors of this motivation. Unquestionably, more models exist that have been constructed to predict pro-environmental behavior, one common denominator of all these models is the

strong focus on individual characteristics. However, in order to design effective interventions, we deemed it important to not only look at individual difference factors, such as biospheric values, but also look at the interaction between different intervention methods when combined and the overall net impact of interventions.

One model that does capture some of the workings of the net impact of interventions is the Elaboration Likelihood Model (ELM; Petty & Cacioppo, 1986). ELM predicts that people process information via one of two routes–central or peripheral–and the model argues that the way people process the information determines whether they will be persuaded by a message. With the peripheral route relying more on how people feel about the information, people essentially take short-cuts in their decision making, and the central route involves more deliberate thinking and processing of the presented information and ultimately coming to a well-considered conclusion. In terms of the net impact of interventions, ELM suggests that the central route results in more lasting changes as compared to decisions made via the peripheral route. However, it is not entirely clear how people can be persuaded to think about a message via the central route, nor does the model give clear directions on how to combine different intervention approaches. Despite the fact that these well-established theories have proven to be very useful in predicting pro-environmental behavior, we considered these models and theories less suitable for the current research. Specifically, the aforementioned models are unable to make clear predictions on how to effectively combine different intervention approaches and the net impact of interventions is often not considered.

To address these issues, we considered construal level theory (Liberman & Trope, 1998; Trope & Liberman, 2003) the most fitting theory as it represents a simple, general framework that is able to capture all three elements. As such, in terms of the effect of values, construal level theory poses that people are only likely to act upon their values when they think at a higher abstraction level (i.e., a high construal level). When interventions are designed at a more concrete, low construal level, it is unlikely that values will play an important role in determining the behavior. Secondly, intervention approaches can be classified along the construal level continuum and we argue that combinations that are at the same construal level are processed more efficiently and thereby have a larger impact on behavior. Finally, the ultimate goal of having a net impact on overall behavior is also captured in construal level theory. We expect that long-term change is most likely to occur, as well as positive spillover, when people think at a high construal level. We, therefore, used construal level theory as a general framework to explain the effectiveness of single as well as combined intervention approaches. As we will elaborate on below, we consider construal level a

key construct for classifying intervention approaches and have specifically studied the effect of construal level manipulations on energy use in Chapters 3-5.

1.5 Construal Level Theory

As noted in the introductory paragraph, construal level theory posits that the same action or event can or will be represented at different levels of abstraction (Liberman & Trope, 1998; Trope & Liberman, 2003; see also Vallacher & Wegner, 1987). This means that people can think of exactly the same behavior at either a low construal level or a high construal level. For example, recycling paper waste can be thought of as preserving the environment at a high construal level, whereas thinking of how to throw the paper in the recycling bin is related to low construal level thinking. Next to the level of abstraction at which construal levels can be distinguished, there are other aspects that set low and high construal level thinking apart. Particularly, a low construal level corresponds with complex, contextualized, subordinate and secondary features of events, whereas a high construal level corresponds with simple, decontextualized, superordinate and primary features of events (Trope & Liberman, 2003).

1.5.1 Psychological distance

People can naturally think at either a low or high construal level but can also be prompted to think at different levels of abstraction. One way different levels of construal can be evoked is by the perceived psychological distance of situations (Trope & Liberman, 2003). Specifically, psychologically distant events are likely to elicit abstract, high construal levels, whereas psychologically close events are likely to elicit concrete, low construal levels. Previous research has often referred to four different psychological distance dimensions: temporal, spatial, social and hypothetical. Psychological distance across these four dimensions refers to when, where, to whom and whether an event occurs (Trope & Liberman, 2010). Temporal distance refers to the distance in time between the self and a situation (e.g., an event that takes place tomorrow versus an event that takes place in ten years). Spatial distance (or geographical distance) refers to the distance in space or location between the self and a situation (e.g., an event in one's city versus an event in another city). Social distance refers to the interpersonal distance between the self and others (e.g., an action with consequences for oneself versus an action with consequences for someone else). Hypothetical distance (or probability distance) refers to the distance in hypotheticality between the self and a situation (e.g., a real, certain situation versus a hypothetical, uncertain situation). In relation to psychological distance, recent research has studied

how people perceive climate change and environmental problems in general (Brügger, Dessai, Devine-Wright, Morton, & Pidgeon, 2015; Singh, Zwickle, Bruskotter, & Wilson, 2017) and shows that climate change is typically regarded as an issue that is distant on all four distance dimensions. This suggests that people are more likely to think of climate change and environmental issues at a high-construal level.

1.5.2 Manipulating construal level

Besides the innate characteristics of certain issues such as climate change, it is also possible to manipulate psychological distance by highlighting either the close or distant aspects of certain situations, objects or events. This, in turn, influences the level of construal at which people mentally represent these situations, objects or events. Moreover, research on psychological distance has shown that the different dimensions are interrelated and a larger distance on one dimension also increases the perceived distance on other dimensions (Bar-Anan, Liberman, Trope, & Algom, 2007; Stephan, Liberman, & Trope, 2011). Next to manipulating psychological distance, construal level can be manipulated directly. Examples of these manipulations are completing a thought exercise on why versus how one would engage in a certain action (Freitas, Gollwitzer, & Trope, 2004), generating superordinate categories versus subordinate examples (Fujita, Trope, Liberman, & Levin-Sagi, 2006), reading abstract versus concrete vignettes (Fujita et al., 2006), processing information globally versus locally (Wakslak & Trope, 2009), and imagining situations from a third-person perspective versus from a first-person perspective (Libby, Shaeffer, & Eibach, 2009). Such manipulations of construal level have also been studied in direct relation to environmental behavior, for example, charitable donations to environmental causes (Obradovich & Guenther, 2016; Rabinovich, Morton, Postmes, & Verplanken, 2009). Ultimately, depending on whether someone thinks at a high-construal or low-construal level determines how someone makes decisions and behaves (Fujita, Clark, & Freitas, 2013; Griffioen, van Beek, Lindhout, & Handgraaf, 2016).

1.5.3 Effect of construal level on behavior

As can be seen in Table 1, low construal level thinking is associated with concrete thinking, *how* to perform behavior, tends to be context-dependent, unrelated to goals, and is typically unstructured. In contrast, high-construal-level thinking tends to be far more structured and simple, is goal-directed, context-independent, concerns *why* to perform behavior and results in abstract thinking. Some have suggested to make environmental issues more personally relevant, thus representing pro-environmental behavior at a low construal level, to increase a sense of urgency (van der Linden et al.,

2015). Others have advocated for high construal level thinking, as this will enable people to act upon their goals and values, which is unlikely to happen when they think at a low construal level (Fujita et al., 2013).

Table 1 *Characteristics of low-construal and high-construal level thinking*

Low-construal level	High-construal level
Concrete	Abstract
Contextualized	Decontextualized
Means focused	Ends focused
Complex	Simple
Unstructured, incoherent	Structured, coherent
Secondary, surface	Primary, core
Subordinate	Superordinate
Feasibility	Desirability
"How"	"Why"

Note. Adapted from Trope and Liberman (2003)

When looking at past interventions, much research has focused on making environmental behavior and its associated benefits more personally relevant, by focusing especially on financial benefits (Bolderdijk & Steg, 2015). From a construal-level perspective, financial appeals would be considered a low-construal-level approach (Hunt, Kim, Borgida, & Chaiken, 2010), whereas appealing to the environmental benefits of behavior are often processed at a higher construal level (e.g., climate change issues; Jones, Hine, & Marks, 2017; Leiserowitz, 2006). Previous research shows that financial appeals (low construal level) can be effective when sparking short-term behavior change (e.g., Jakovcevic et al., 2014), but long-term change is often unlikely (Bolderdijk & Steg, 2015). Different explanations have been provided for the short-lived effectiveness of financial appeals; it has been suggested that extrinsic rewards may "crowd-out" intrinsic motivation (Deci, Koestner, & Ryan, 1999), whereas other research argues that people may adopt a cost/benefit mindset and believe the costs of acting in a sustainable manner outweigh the financial benefits (Dogan, Bolderdijk, & Steg, 2014). Alternatively, from a construal level theory perspective, we suggest that financial appeals lead to low-construal-level thinking, which in turn is highly susceptible to contextual changes. Therefore, when the situation changes, the low-construal level reason for acting in a sustainable manner may not be considered any longer and people may not see a reason to act accordingly.

In order to realize long-term behavior change, it therefore seems to be more promising to focus on high-construal-level thinking and interventions. For individuals who highly value the environment, high-construal-level thinking may enable them to act more upon these values (Giacomantonio, De Dreu, Shalvi, Sligte, & Leder, 2010) and behavior is less affected by situational changes. Moreover, people are less likely to see potential barriers and focus more on the desirable end-state they want to reach (Fujita, Eyal, Chaiken, Trope, & Liberman, 2008; Liberman & Trope, 1998). This suggests that when people have an abstract goal of reducing their impact on the environment, this will not be solely contained to one situation or behavior.

As argued earlier, for behavior to be actually environmentally-friendly, it should not only impact the target behavior, but also have a positive impact on other related behaviors (i.e., positive spillover). From a construal-level-theory perspective, we expect that high construal level thinking would facilitate perceptions of similarities between different types of behaviors that all share the same goal and thus positive spillover. For example, when someone values the environment and deems it important to conserve energy, when an intervention is targeted at changing water use behavior, high-construal-level thinking will likely facilitate considerations of other energy-related behaviors. In line with this reasoning, Conway and Peetz (2012) suggest that high-construal-level thinking will most likely enable consistency considerations. Specifically, positive spillover to related energy-use behaviors is expected when people think at a high-construal level, as people want to act in a consistent manner. This expectation may also be related to the fact that people want to be perceived as competent and consistent (Bem, 1967). When someone acts in an environmentally-friendly manner on one behavior, this may inform the individual about what kind of person he or she is, which in turn influences how subsequent decisions are made. This is in line with research by van der Werff, Steg, and Keizer (2014), who show that when past behavior informs people about what kind of person they are (i.e., an environmental person), their environmental self-identity is strengthened, and are more likely to portray subsequent pro-environmental behavior. Moreover, previous research has also shown that actually appealing to the environmental benefits of behavior, related to higher construal-level thinking, can facilitate long-term change and result in positive spillover to related energy-use behaviors (Evans et al., 2013; Steinhorst, Klöckner, & Matthies, 2015).

In contrast to high-construal-level thinking, when people are motivated to reduce their water use at a low-construal level, people solely focus on this behavior and are unlikely to see similarities with other energy-related activities. Following this reasoning, we would expect no spillover. In other words, simply conserving energy

fulfills the goal that an intervention may have targeted, and this person does not need to act in an environmentally-friendly manner on other behaviors (Garvey & Bolton, 2017). Whether people actually portray negative spillover or do not change other energy-related activities may depend on whether they perceive the behaviors to be related or not. As such, when someone believes that energy use when taking a shower is related to one's total energy use at home, some negative spillover may occur. Conway and Peetz (2012) argue that low-construal-level thinking evokes compensatory mechanisms and when people do see similarities between different types of behavior, they may be more likely to portray negative spillover behavior.

Based on construal level theory and previous findings, we have specified expectations for the short-term, long-term and spillover effects of both low and high construal level manipulations. As shown in Table 2, we expect that short-term behavior change can be sparked by both low-construal and high-construal level approaches. In order to have a large environmental impact, we expect that high-construal level interventions will be more effective, as we anticipate more long-lasting effects and positive spillover to different types of behaviors.

Table 2 *Expectations for different construal level interventions*

	Short-term	Long-term	Spillover
Low construal level	Strong positive effect	No effect	Negative/no effect
High construal level	Positive effect	Positive effect	Positive effect

1.6 Combining construal level interventions

As previous research has suggested that combined intervention approaches can be more effective than single approaches, another aim of this dissertation is to understand how combinations of intervention methods can be designed to have the largest impact on behavior. Here we again consider construal level an important predictor of how effective such combinations are. When we classify intervention methods based on their level of construal, two types of combinations can be made: congruent and incongruent approaches. Congruent approaches are combinations of interventions which are both either at a high-construal level or at a low-construal level. Incongruent approaches, in contrast, are those combinations that include one intervention at a low-construal level and one at a high-construal level.

Field studies on the fit between two construal-level manipulations are rare, especially in the field of pro-environmental and energy-use behavior. However, a number of studies have looked at the effectiveness of combinations in more controlled

settings (online surveys or laboratory setting) on pro-environmental intentions and behavior. Rabinovich et al. (2009) argue for complementarity (i.e., incongruence) between two approaches based on value-expectancy theory, with the high construal level facilitating the value of a behavior and the expectancy component is mostly thought of at a low-construal level. Across two studies the authors find support for combinations that are incongruent (i.e., high combined with a low construal level), but note that the generalizability of their findings may be limited due to the type of manipulations they used, the targeted behavior (donation to charity) and the short-term nature of their experiment. Moreover, in terms of the combinations of the two construal-level manipulations, the authors were clearly interested in setting either a concrete or abstract goal and linking that to either a specific or abstract mindset. Due to the sequence of their manipulations and the fact that both manipulations were targeted at the same behavior, it should be investigated further whether their findings would also hold in longer-term situations, with different manipulations and providing the manipulations in a different order. The cautiousness related to the interpretation of the results may stem from the fact that most studies that investigated combinations of construal level manipulations found support for congruency (i.e., two manipulations at the same level). More specifically, previous work has mostly suggested that people process information more efficiently when two construal-level manipulations are congruent as compared to incongruent combinations (Amit, Algom, & Trope, 2009). Both White, MacDonnell, and Dahl (2011) and Chang, Zhang, and Xie (2015) looked at the effectiveness of a construal-level manipulation in combination with message framing (i.e., gain vs. loss frames). They argue that combinations that are at the same construal level are more effective (i.e., congruent approaches). Specifically, Chang et al. (2015) argue that loss frames activate negative feelings, which are related to lower construal-level thinking, and gain frames evoke more positive feelings, which are related to higher construal-level thinking (Labroo & Patrick, 2009). Therefore, they argue that different message frames (indirectly) evoke different construal levels and in turn when the message is congruent in terms of its resulting construal level, messages will be more persuasive. In line with their theorizing, both studies show that congruent approaches, either at a high level or a low level, were more effective in terms of recycling intentions (White et al., 2011) and purchase intentions (Chang et al., 2015). Similarly, Goldsmith, Newman, and Dhar (2016) studied the congruence between highlighting self-enhancing or self-transcendent benefits and a temporal-distance manipulation. Again, even though the two manipulations are not directly manipulating construal level, the authors argue that self-transcendent benefits fit better with high-construal-level thinking, whereas

self-enhancement benefits seem to be more appropriately linked with low-construal-level thinking.

In line with much of the previous work, we expect that congruent intervention approaches are more effective as compared to incongruent approaches. Specifically, we expect that combinations that are at the same construal level are processed more efficiently. Particularly, congruent approaches will allow both construal level manipulations to reinforce one another. In case of incongruent construal level combinations, we anticipate that the low-construal-level component will drive behavior change and the effect of the high-construal-level approach will be pushed aside. Important to note is that most studies did not contrast the effectiveness of combined intervention approaches to the effectiveness of each individual intervention approach in isolation. We deem this an important issue to study as well, as this will shed more light on when a combination actually results in greater energy reductions, or whether the difference with singular approaches is negligible or even negative. Based on construal level theory we argue that the effectiveness of the singular approach is important in determining the overall effectiveness of combinations and especially for incongruent approaches. As low-construal levels have been argued to be more readily available to people, because they often represent more concrete and immediate considerations (Fujita et al., 2013), we anticipate that the low-construal-level component will drive behavior in incongruent approaches. Therefore, when the low-construal-level intervention is ineffective by itself, combining this intervention with a successful high-construal-level approach will not result in the desired behavior change. Moreover, the high-construal-level component will not be considered by people and therefore not have an effect on behavior. We pose that this could also be a potential explanation for findings by Schwartz, Bruine de Bruin, Fischhoff, and Lave (2015) on the effectiveness of message appeals that combined financial and environmental information. They found that highlighting financial and environmental benefits at the same time did not result in the desired behavior change, while focusing on environmental benefits alone was effective. We argue that financial information evokes low-construal-level thinking (Hunt et al., 2010), and as the financial message by itself was not effective, the combination with the effective environmental message did not have a positive effect on behavior (i.e., signing up for an energy saving program). However, at the same time, when the low-construal-level intervention is effective by itself, we expect that a combination with a high-construal-level approach will be equally effective as the low-construal -level intervention in isolation. In Chapter 3 we test the effectiveness of an incongruent combined message appeal in comparison to single message appeals, and in Chapter 4 we extend these

findings by researching different construal level combinations (i.e., congruent and incongruent combinations).

1.7 How to measure behavior (change)?

In order to establish whether construal level manipulations are effective, it is important to specify how behavior is measured. Many studies have looked at energy use behavior (mostly in the household setting) and have used different measures of energy use. Most often, research relies on self-report measures (Steg & Vlek, 2009), which are relatively easy to retrieve via questionnaires. Specifically, survey studies often include questions on how often people engage in different types of pro-environmental activities, such as recycling, switching the light off when nobody is in a room, and transportation choices. Another way to measure energy use behavior is to look at the actual electricity, water or gas used, which is a more objective way of measuring behavior. A recent meta-analysis by Kormos and Gifford (2014) on the association between self-report and objective measures of pro-environmental behavior revealed that there is a significant correlation between both measures, but the unexplained variance remains high (79%). This is in line with earlier findings from Gatersleben, Steg, and Vlek (2002) who did not find a strong relation between self-reported pro-environmental behavior and objectively-measured energy use. This raises the question on what kind of measure to rely when studying energy use behavior. On the one hand, self-report measures may be preferred as these measures can give more insight in what people are actually doing (Gatersleben et al., 2002). For example, self-reports can shed more light on what kind of appliances people have and how they use such appliances. However, self-report measures are subjective in nature and answers can be tainted by social desirability considerations, either due to impression management or to self-deceptive enhancement (Lalwani, Shrum, & Chiu, 2009; Paulhus, 2002). On the other hand, objective measures may be preferred as this allows for direct comparison between different individuals (or households) without the social desirability issues revolving around self-report measures. Objective measures are, however, often more expensive and difficult to unobtrusively implement. Moreover, simply knowing how much energy people use does not tell a lot about the way people use different appliances, for example, which is information that can only be retrieved via self-report measures. Therefore, even though both measures have clear advantages and disadvantages, the best way forward would be to include both measures in order to get a relatively complete understanding of how people behave.

The fact that self-report measures and objective measures of energy use do not correspond completely can also be due to the fact that surveys are often filled in by

one person within a household, whereas the energy use is measured for the entire household. In order to address this issue, we specifically focus on individual energy use behavior in this dissertation, which allows us to relate individual self-report measures to individual energy use behavior. More specifically, a number of the studies (Chapter 3, 4 and 5) have been carried out at The Student Hotel (TSH). TSH is a hotel, student housing and short-stay concept founded in the Netherlands. Students can stay for a maximum of a year at TSH, whereas hotel and short-stay guests stay for a couple of nights or weeks. Due to this set-up, we were able to have a constant flow of new participants. Moreover, in 2014, measurement equipment was installed in 156 rooms and 18 kitchens at two locations of TSH. This allowed us to measure individual energy use in terms of lighting, socket use, warm water use, thermostat use, and presence in the rooms and compare this with self-reported attitudes and behavior. The rooms containing measurement equipment were occupied by students during the academic year and by regular hotel guests during the summer months (July and August). Students staying at TSH are only allowed to stay in the rooms alone, at least for the rooms we measured the energy use in. This allowed us to relate individual energy use to various individual difference factors collected via questionnaires. Next to the field experiments, the study in Chapter 2 was done in a laboratory setting, where we studied the effectiveness of an investment in an energy-efficient light bulb on curtailment behavior. In the laboratory participants did not pay for the energy they used, but we had more control over what they were doing as compared to the studies carried out at TSH.

1.8 Outline of this dissertation

In this dissertation we study the effectiveness of interventions targeted at energy saving behavior when people "do not pay the bill." In other words, we are specifically interested in the effectiveness of different intervention approaches when people do not financially benefit from changing their behavior. To study the issues surrounding energy conservation behavior, we have conducted online surveys, laboratory experiments and field experiments.

In **Chapter 2** we first focus on the relation between curtailment and investment behavior, without specifically applying construal level theory. As people are usually only able to change their curtailment behavior when they are not responsible for paying the bill, we were interested in the downstream effects of an investment in an energy efficiency measure. Moreover, we were especially interested in whether energy use behavior differed between participants who had invested in the energy-efficient appliance themselves or whether this was done for them by the researcher.

Additionally, we varied whether the investment was done for environmental or financial reasons. We studied this in a laboratory experiment, which allowed us to test the effects in a very controlled setting and with objective behavioral outcome measures. As we did not approach this chapter from a construal level theory perspective, we will elaborate on our findings from a construal level perspective in the final chapter (Chapter 6) and discuss how this relates to our findings in the other empirical chapters.

In **Chapter 3** we studied the effectiveness of different types of messages that highlighted either personal benefits (i.e., health benefits) or environmental benefits and focused on water use behavior. We were particularly interested in the effectiveness of messages highlighting one benefit as compared to the effectiveness of the message that highlighted both benefits at the same time. We specifically classified the different message appeals using construal level theory. As such, we tested the effectiveness of a low construal level message (i.e., health), a high construal level message (i.e., environment) and a combination of the two construal levels (i.e., health and environment). We studied this behavior in an online survey (via mTurk) and in a real hotel setting. This allowed us to have both self-reported intentions and actual behavioral measures. As our results from Chapter 3 did not indicate that the combined message was more effective, we were interested in forming effective combinations of intervention approaches to stimulate water saving behavior.

Therefore, in **Chapter 4** we looked at the effectiveness of a construal level manipulation in combination with a social distance manipulation. This study was carried out with a student sample and we measured energy use throughout a 6-week period.

In **Chapter 5** we report the results of our final field study at TSH, where we again looked at the combined effectiveness of two intervention approaches. Similar to Chapter 4, we asked participants to complete a construal level manipulation and on top of that manipulation participants received real-time feedback on their shower use for one month. We were particularly interested in the long-term effect of our manipulations, especially when participants did not receive real-time feedback any longer. Across all field studies we have included analyses for potential spillover to other related energy-use behavior.

Finally, in **Chapter 6** the results from the four empirical studies are synthesized and the theoretical implications are discussed. Specifically, taken from these different studies we will summarize in what kind of situations (short-term vs. long-term situation) what kind of construal level interventions are most suitable.

Chapter 2

Is it a bright idea? The influence of energy efficiency investments on curtailment behavior

This chapter is based on Griffioen, A. M., Hardisty, D. J., Handgraaf, M. J. J., & Zhao, J. (*under review*). Is it a bright idea? The influence of energy efficiency investments on curtailment behavior.

Abstract

Reductions in individual energy use can be realized by engaging in different activities, which are often classified as either curtailment behavior (i.e., changing day-to-day behavior) or investment decisions (i.e., buying energy-efficient appliances). Investment decisions have been suggested to be more impactful in terms of potential energy reductions. Yet, in reality, the projected energy savings are often not attained, which suggests that the way people behave may alter after an investment is made. We therefore tested this in a controlled laboratory setting, where we measured the effect of an investment in an energy-efficiency appliance (i.e., an LED light bulb) on curtailment behavior (i.e., likelihood of switching the light off in different rooms). We studied how curtailment behavior was affected after an investment was made with either a focus on financial or environmental benefits and either made by participants themselves or by someone else. Our results suggest that the use of an environmental frame has positive effects on curtailment behavior, both when the investment was made personally or when someone else invested in the energy-efficient light bulb. Focusing on the financial benefits of energy reductions proved to be less effective. Particularly, when someone else had invested for monetary reasons, participants engaged in less curtailment behavior as compared to the other conditions. We discuss the implications of these results, while contrasting it to previous findings on licensing and spillover behavior.

Keywords: curtailment behavior, investment behavior, framing, licensing, spillover

2.1 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. This choice could be based on the projected monetary savings or because of the lower environmental impact. 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 the 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 et al., 2009; Stern, 2000). These two categories are often referred to as investment behavior (e.g., buying energy-efficient light bulbs) and curtailment behavior (e.g., switching lights off), respectively. Although energy efficiency investments usually have a larger impact than curtailment actions (Attari et al., 2010), individual's curtailment behavior still plays an important role in deciding whether to make an investment in the first place, but also in how individuals behave after the investment is made (Tetlow et al., 2015). Specifically, when people simply adopt new technologies but do not use them properly (e.g., purchasing efficient light bulbs but then leaving the lights on more often), the anticipated positive impact on the environment tends to be smaller than projected.

In recent years, studies in the environmental domain have almost exclusively focused on curtailment behavior (Jansson, Marell, & Nordlund, 2010) and the interaction with investment behavior is thereby disregarded. In reality, both behaviors occur concurrently and are likely to influence one another. 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. Moreover, the reasons why investments are made are often not considered (i.e., environmental and/or financial reasons), whereas previous studies have shown that framing positive or negative consequences in either environmental or financial terms can influence behavior (e.g., Bolderdijk, Steg, Geller, Lehman, & Postmes, 2013). Therefore, this research aims to address the following questions: how does an investment in an energy efficiency appliance influence subsequent curtailment behavior? Does it matter whether people make the investment

themselves or whether it is done by a third party (e.g., a landlord)? And finally, does framing the investment in either financial or environmental frames affect curtailment behavior? In order to rule out other factors, we study these questions in a controlled laboratory experiment, in which participants are asked to engage in both curtailment and investment behavior.

2.1.1 Financial and environmental framing

In order to improve energy efficiency and thus reduce the impact of energy use on the environment, people can engage in different activities that can be classified as curtailment and investment behavior. Curtailment behavior requires people to engage in activities on a repeated basis, it rarely involves any monetary investments, and it usually requires constant effort (Jansson et al., 2010; Ritchie & McDougall, 1985). This is in contrast to investment behavior (sometimes also referred to as efficiency behavior, see Karlin et al. (2014)), as individuals will only have to make the decision to invest once or twice, after which they can reap the benefits of this decision. This thus involves some upfront (monetary and time) investment, but individuals are likely to benefit (financially) from the investment in the future and it does not require individuals to exert constant effort.

As people have to spend money when investing in an energy-efficient appliance, previous studies have highlighted the potential monetary benefits and show that it is effective when aimed at investment decisions (Bolderdijk & Steg, 2015; Gärling & Schuitema, 2007; Handgraaf et al., 2017; Jakovcevic et al., 2014; Stern, 2000). Unfortunately, financial appeals have proven to be rather ineffective when aimed at changing curtailment behavior, and the focus on environmental benefits actually proved to be more effective (Asensio & Delmas, 2015; Bolderdijk, Steg, et al., 2013; Dogan et al., 2014; Schwartz et al., 2015). Taken together, previous studies have not provided a clear direction on whether environmental or financial framing is more effective when aimed at changing both curtailment and investment behaviors. We are, therefore, not only interested in the influence of a framing manipulation on a target behavior (e.g., investment behavior) but also on another related behavior (e.g., curtailment behavior). This is often referred to as spillover behavior, which is defined as the impact the change in one behavior has on other behaviors (Nilsson, Bergquist, & Schultz, 2017; Thøgersen & Crompton, 2009). The spillover is negative when people engage less in other pro-environmental behaviors after acting more environmentally friendly on an initial behavior; the spillover is positive when people engage more in subsequent other pro-environmental actions.

In addition, researchers are stressing the need to focus not only on the immediate effect an intervention has on a target behavior, but also look at the long-term effects as well as the spillover effect (i.e., "net environmental impact"; Truelove, Carrico, Weber, Raimi, & Vandenbergh, 2014). Moreover, the interaction between curtailment and investment behaviors remains largely understudied (Garvey & Bolton, 2017). Despite this apparent gap in the literature, multiple review papers (Dolan & Galizzi, 2015; Mullen & Monin, 2016; Nilsson et al., 2017; Truelove et al., 2014) have outlined potential factors that may influence whether positive or negative spillover is more likely to occur. Even though studies on spillover behavior usually concern curtailment behavior in different pro-environmental domains, the principles that have been studied may apply in a similar fashion to the interaction between curtailment and investment behaviors.

2.1.2 Curtailment after investment

One survey study by Jansson, Marell, and Nordlund (2010) examined the interaction between curtailment and investment behaviors in terms of participants' car use. One notable finding from their study is 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, it is not clear whether people who engaged in investment behavior were less likely to subsequently engage in curtailment behavior or whether people who engaged less in curtailment behavior were more likely to invest in energy efficiency appliances. McCoy and Lyons (2017) tackled the causality issue and specifically studied the effect of changes in curtailment behavior on investment behavior and showed that an intervention targeted at curtailment behavior (overall and peak energy usage) decreased the likelihood that people would invest in energy-efficient appliances. This finding showed that curtailment behavior had a negative effect on investment behavior but did not show the potential negative or positive effects of an investment in energy-efficient appliances on curtailment behavior. Although there is little research on the causal effects of investment behavior on curtailment behavior, studies on licensing behavior help shed more light on this relationship.

2.1.3 Licensing

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). Licensing thus suggests that acting pro-environmentally on one behavior may lead to less pro-environmental inclinations on another behavior. The

underlying process that explains licensing behavior has been described by two different accounts (Mullen & Monin, 2016): credits and credentials. The credits model poses that people accrue moral credits when they act in a good or moral manner and they can spend these credits later on by engaging in less desirable behaviors. The credentials approach differs slightly from this, as it suggests that people interpret their behavior through a moral lens. Instead of accruing credits over time, people simply interpret their subsequent behavior as being less immoral (Monin & Miller, 2001). Both approaches would predict that licensing, or negative spillover, is more likely to occur when people have made an investment in an energy-efficient appliance.

Moreover, when people have made the investment with environmental reasons in mind, they may have accumulated more moral credits as compared to making this investment on purely financial grounds. The fact that someone is putting effort in doing the "right" thing signals that you are a moral person (Venhoeven, Bolderdijk, & Steg, 2013). Whether someone perceives the behavior to be moral may thus 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 (by focusing on the financial benefits of the behavior). When people engage in pro-environmental behavior for non-moral reasons (i.e., getting paid for it) they may not feel as good about their behavior and thus not accrue moral credits or credentials (Bolderdijk, Steg, et al., 2013). This would suggest that licensing behavior is more pronounced among people who have invested in products for environmental reasons compared to those who have invested for financial reasons, since the former may have more moral credits to spend.

From a licensing perspective, it seems as if previous desirable pro-environmental behavior would always lead to negative future behavior. However, 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 et al., 2015). In contrast to the licensing literature, these findings seem to suggest that environmental framing should be preferred over financial framing in terms of having the largest impact on multiple pro-environmental behaviors. The difficulty with this claim is that studies on spillover behavior are often limited to curtailment behavior and spillover from investment to curtailment behavior within the same domain has been far less studied.

2.1.4 Self-identity

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; Truelove et al., 2014). 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. Similarly, in a recent study by van den Broek, Bolderdijk, and Steg (2017), the authors found that messages were most effective when the appeal was in line with participants' values. In terms of environmentally and financially framed messages, this would suggest that when people mostly endorse egoistic values, appealing to financial benefits may be the most effective method, whereas people who are more concerned about the environment (i.e., score high on biospheric values) will most likely respond positively to environmental messages. Likewise, Garvey and Bolton (2017) found that environmentally-conscious participants showed higher intentions to buy environmentally-friendly products after they had just imagined purchasing another environmentally-friendly product, which the authors argue is due to self-perception concerns. Similarly, correlational research by Peters, van der Werff, and Steg (2018) showed that the purchase of an electric vehicle for environmental reasons was strongly related to higher levels of environmental self-identity and in turn more pro-environmental behavior. Taken together, from a self-perception perspective, whether people will engage more or less in curtailment behavior after making an investment may depend on how they regard the investment. If they think that the reason for the investment is in line with their values and identity, positive spillover may occur because people want to act in a consistent manner. If participants feel that the initial investment is not related to their values or self-identity, spillover may not happen at all (or could be negative).

2.1.5 Self vs. other investment

Literature on spillover and licensing behavior often focuses on actions that people have engaged in themselves and study how this affects their subsequent behavior. In day-to-day life, however, there are many situations in which people do not necessarily control what kind of appliances they use or how well a building is insulated. This is the case when people are at work, at school, at a hotel or in a public building. Across all the latter situations, people are the end users and thus influence the energy use. Therefore, the energy-saving potential of energy-efficient measures in these buildings depends on individual users and their behavior can 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.

Purely from a licensing perspective, when someone else makes an investment, an individual does not accrue any moral credits or credentials, 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. Nevertheless, research on social norms would suggest otherwise, as 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; Nolan, Schultz, Cialdini, Goldstein, & Griskevicius, 2008). 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, this 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 that is made salient when an investment is made 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.

2.2 Current research

In the current study we want to investigate how energy efficiency investments affect subsequent curtailment behavior, as the true energy efficiency of an investment can only be determined when the impact on day-to-day curtailment behavior is measured. We will 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 will manipulate two factors that we deem important for influencing light use behavior: 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 have two

competing theories that predict opposite effects in terms of positive or negative spillover behavior. First of all, from a licensing perspective, we would expect that negative spillover is most pronounced among participants who have invested themselves. Moreover, we expect that the licensing effect is larger among participants in the environmental message condition as compared to the financial message condition. This prediction is based on the fact that people may feel as if they have accrued more moral credits or credentials when they have portrayed their initial behavior for environmental reasons. When someone else makes the investment, we do not expect any differences in light use as compared to baseline use. According to licensing theory, people only accrue credits or credentials when they have engaged in certain behavior themselves. Therefore, we expect that behavior will be unaffected if someone else invests in more energy-efficient appliances. Table 1 shows our expectations from a licensing perspective (in terms of curtailment behavior after an investment is made).

Table 1 *Expected effects on curtailment behavior after investment is made (licensing perspective).*

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

In contrast, a self-perception and social norms perspective suggests that when investments made by participants themselves, the environmental frame will lead to a positive spillover to curtailment behavior, whereas the financial frame will not alter curtailment behavior. When the investment is made by someone else, we expect that when the investment is made with environmental reasons in mind, positive spillover to curtailment behavior is again more likely to occur, as it signals a pro-social, pro-environmental norm. In contrast, when someone else invests for only financial reasons, which signals a self-enhancing norm, we expect negative spillover to curtailment behavior (i.e., more light use). Even though this may seem counterintuitive at first glance, we contend that in situations in which someone else can make an investment for financial reasons, those who actually have to engage in the subsequent curtailment behavior (i.e., the end users) are unlikely to benefit financially from changing their behavior. In other words, when a hotel decides to put more efficient light bulbs in its hotel rooms for financial reasons, it is not rational or in an individual's best self-interest to reduce the light use in that room. Instead, acting in a self-enhancing manner in such situations would suggest that someone does not

want to put time or effort in reducing their energy use. Table 2 shows our expectations based on a social identity and social norms perspective.

Table 2 *Expected effects on curtailment behavior after investment is made (social norms and 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

2.3 Method

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, M_{age} = 20.34, SD_{age} = 3.96). Participants were randomly assigned to conditions in a 2 (Message: environmental vs. financial) × 2 (Investment: self vs. other) 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 first round of tasks in different rooms (i.e., 5 irrelevant tasks) in which we measured how often participants switched the light off. After the first round, participants were randomly assigned to one of the four manipulations and an investment in more energy efficient LED light bulbs was made. Similar to the first round of tasks, after the investment, participants were asked to complete another round of tasks (this time with different, more efficient light bulbs). Finally, participants were asked to complete a survey on a computer, and we measured whether they switched the light off at the end of the experimental session.

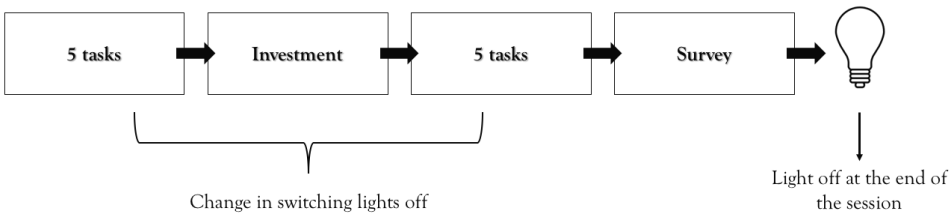


Figure 1 Design of experiment; Measuring the change in light switching behavior from Round 1 (first 5 tasks) to Round 2 (second 5 tasks). At the end of the session, we measured whether participants switched the main light off.

First round of tasks. While sitting in the main room, a researcher explained to participants that they would complete a number of tasks in the four different rooms of the laboratory (see Appendix 1 for the set-up in the laboratory and Appendix 2 for the tasks). Participants were explicitly instructed to try to complete the tasks as fast as they could and were told that the researcher would keep track of their time while they were completing the tasks. These tasks were irrelevant to the investment or the curtailment behaviors. All four rooms had a desk lamp with an incandescent light bulb, which participants used to complete the tasks. After the instructions, the researcher gave the first task to the participant and directed the participant to the room to complete the task in. 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 (in minutes), whether participants switched the light off at the end of the task (0 = no, 1 = yes), and how well they did on the tasks (in percentage correct). After the fifth task, participants were asked to sit down again and complete an unrelated survey, which took about 3 minutes to complete. After completing this unrelated survey, participants were told that we were moving back to the tasks in the different rooms.

Manipulation. At this point, participants were randomly assigned to the 2 (Message: environmental vs. financial) × 2 (Investment: self vs. other) between-subjects design. Participants were either asked to change the incandescent light bulbs for energy-efficient LED lights themselves (which they could also refuse to do) or they were told that the researcher would change the light bulbs for the second round. Moreover, participants were told that the light bulbs were changed for either environmental reasons or financial reasons. This design led to four separate manipulation texts, which are shown in Appendix 3.

Second round of tasks. After the light bulbs had been changed (either by participants themselves or the researcher; 10 participants refused to change the light bulbs and kept the incandescent light bulbs for the second round[1]), participants were asked to complete five more tasks in the different rooms. This followed the same procedure as in the first round of tasks. The tasks were similar to the tasks in the first round and

[1] Participants who refused to change the light bulbs 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.

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 frequent curtailment behavior in daily life (e.g., turning off lights multiple times a day when leaving rooms).

Survey. 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.

To investigate whether individual differences in values might moderate the effects, participants were first asked to fill out four different subscales from Schwartz's (1992) value scale on a 9-point importance scale (−1 = *opposed to my principles,* 0 = *not important,* 7 = *extremely important*). We included the items for biospheric values (e.g., "respecting the earth: harmony with other species"), altruistic values (e.g., "equality: equal opportunities for all"), egoistic values (e.g., "social power: control over others, dominance"), and hedonic values (e.g., "pleasure: gratification of desires"; 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 (e.g., "I see myself as an environmentally friendly person"; van der Werff, Steg, & Keizer, 2014) on a 7-point Likert scale (1 = *strongly disagree,* 7 = *strongly agree*). 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", "I switch appliances off instead of leaving them on standby") 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) on a 7-point Likert scale (1 = *totally disagree,* 7 = *totally agree*).

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") and participants were also asked whether they believed that their light use has a large impact on the environment or their energy bill on 7-point

Likert scales (1 = *strongly disagree*, 7 = *strongly agree*). All means and standard deviations of the items in the questionnaire are reported in Table 3.

Finally, participants were asked for demographic information (i.e., age, gender, nationality, political orientation and study program). After completing the survey on the computer, the 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. When participants left the room in which they completed the survey, we recorded whether they switched the light off when leaving the room they completed the survey in. 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 self-report measures from survey*

	Number of items	Mean	SD	Cronbach's α
Values				
Biospheric	4	7.13	1.19	.793
Altruistic	4	7.66	0.97	.627
Egoistic	5	6.50	1.15	.694
Hedonic	3	7.70	1.04	.704
Environmental identity	3	5.05	1.03	.926
Energy behavior	15	3.95	0.80	.714
Consistency	7	4.29	1.00	.849

2.4 Results

2.4.1 Manipulation checks

As a manipulation check of who changed the light bulbs, we asked participants to what extent they thought the replacement of the light bulbs was their own decision. As expected, participants who were given the choice to replace the light bulbs themselves thought it was their own decision ($M = 5.68$, $SD = 1.72$), whereas participants in the other condition thought it was not their own choice ($M = 1.97$, $SD = 1.34$; $F(1,194) = 284.42$, $p < .001$, $\eta_p^2 = .594$). Additionally, we asked participants what the main reason was for replacing the light bulbs. Table 4 shows what people answered to this question in each experimental group. We performed a three-way loglinear regression and our model retained all effects, indicating that the three-way interaction was significant (message × investment × manipulation check; $\chi^2(1) = 4.36$, $p = .037$). To understand this interaction, we looked at the chi-squared tests for

participants in the self and other condition separately. We found that message had a significant effect on the manipulation check in both the self condition ($\chi^2(1) = 5.42$, $p = .030$) and the other condition ($\chi^2(1) = 29.83$, $p < .001$). Calculating the odds ratio for both groups, we found that participants in the financial message condition were 4.25 times more likely in the self condition and 30 times more likely in the other condition to indicate they changed the light bulb for financial reasons as compared to the environmental message condition[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

2.4.2 Switching lights off (curtailment behavior)

Switching lights off after tasks. As a very explicit measure of curtailment behavior after an investment was made, we measured whether participants were more or less likely to switch the light off in the second round of tasks as compared to the first round of tasks after they (or the researcher on their behalf) had replaced the light bulbs. Using R (R Core Team, 2017) and *lme4* (Bates, Mächler, Bolker, & Walker, 2014) we performed a binary logistic mixed models analysis of the relationship between the investment and message manipulations on switching the light 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 controlled for potential time trends throughout the 10 tasks, by including a variable for task number. The percentage of participants who switched the light off at the end of each task is depicted in Figure 2. We looked at the odds for switching the light off in the second round (last five tasks) as compared to the switching off behavior in the first round (i.e., the first five tasks).

[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.

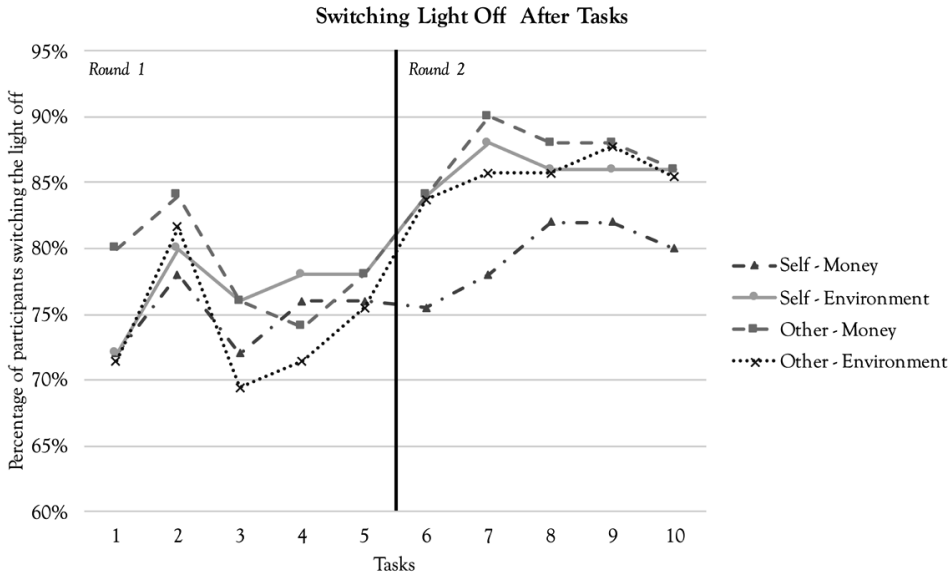


Figure 2 Percentage of participants who switched the light off at the end of each task; Round 1 (first five tasks, before the light bulbs were replaced) is marked in grey. The remaining tasks (6 to 10) were in Round 2.

Participants in the environmental message condition were more likely to switch the light off in the second round when they replaced the light bulb themselves (odds = 3.82, $z = 2.33$, $p = .020$), which significantly differed from 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 light off in the second round (odds = 23.57, $z = 4.18$, $p < .001$). This is in line with our expectations from a social norms and identity perspective, as we expected a strong positive effect on curtailment behavior when participants received environmental information.

In line with our hypothesis from a social norms and identity perspective, participants in the financial message condition were not more likely to switch the light off in the second round when they replaced the light bulbs themselves (odds = 1.04, $z = 1.10$, $p = .273$)[3]. Likewise, we found a marginally significant interaction between message type and round for participants who replaced the light bulbs themselves: when reading environmental information participants were more likely to switch the light off in the second round as compared to participants who read the financial

[3] However, when we excluded the participants who refused to change the light bulbs from the analysis, we found that participants in the "Self-Money" condition were 4.10 times more likely to switch the light off in the second round as compared to the first round ($z = 2.40$, $p = .017$).

message (odds = 2.66, z = 1.65, p = .098). Finally, and 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). In summary, the results are mostly consistent with the predictions from the social norms and identity perspective. However, the results from the "Other – Money" condition were opposed to our expectations, as participants in this condition were also more likely to switch the light off in the second round.

During the tasks we also recorded the performance and time spent on each task. To rule out any alternate explanations for switching off behavior, we also analyzed whether our conditions had an effect on time or 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.

Light off at end of session. In addition to our explicit measure of curtailment behavior, we also measured whether participants switched the light off at the end of the experimental session, as a more implicit measure of curtailment behavior. We performed a binary logistic regression on switching off behavior at the end of the experiment (after participants completed the survey) to detect differences between the experimental manipulations, while controlling for how often participants on average switched the light off during the first five rounds of tasks (as a measure of baseline behavior). Figure 3 shows the percentage of participants per condition that switched the light off at the end of the session.

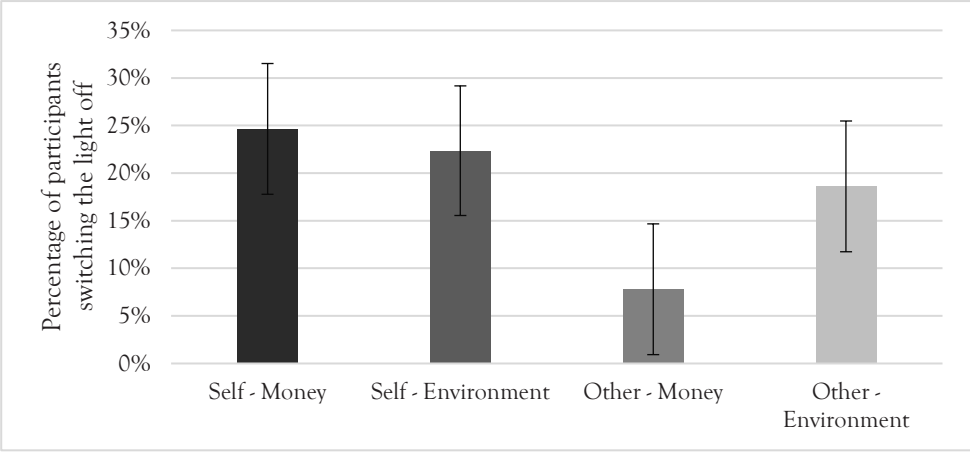


Figure 3 Estimated marginal means for percentage of participants who switched the light off at the end of the session, while controlling for average switching off behavior in the first round of tasks (as a baseline measure). Error bars represent ± 1 SE.

As depicted in Figure 3, in line with our hypothesis from a social norms and 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 the "Self-Money" condition significantly differed from the "Other-Money" condition. More specifically, participants in the "Self-Money" condition were 3 times 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 2.59 times more likely to switch the light off, which was marginally significant (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. 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.

Table 5 *Odds of switching lights off as compared to the other conditions, while controlling for "baseline" 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. Therefore, when the confidence interval includes 1, the difference between the two conditions is insignificant.

2.4.3 Self-report measures

We were interested in whether our manipulations affected the way people perceived themselves in terms of being an environmentally-friendly person, as measured by the environmental self-identity scale. We performed an analysis of variance (ANOVA) to test the effect of our 2×2 design. In terms of 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)[4]. We did not find a significant effect of message on environmental self-identity (F(1,194) = 0.04, p = .852, η_p^2 = .852)[5] nor an interaction between who invested and message type (F(1,194) = 0.02, p = .904, η_p^2 = .904).

Next to our behavioral outcome measures on the tasks, we also asked participants a number of questions on how they experienced the tasks and how big they deemed the environmental and financial impact of their light use. We asked participants to what extent they agreed with statements about the tasks. We did not find any significant differences between the conditions for the following statements: "I enjoyed completing the tasks," "I finished the tasks as fast as I could," "I always switched the light off after I finished a task," "I thought the tasks were difficult to complete," "I believe switching my lights off has a large impact on the environment." On the other items we did find one or more significant effects of our manipulations. First of all, how much participants liked the different light bulbs was influenced by whether they changed the lights themselves or not. We asked participants whether they liked the incandescent light bulbs better, and 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 for monetary reasons (M = 5.34, SD = 1.47) liked the light bulb significantly better as compared to those who let the researcher replace the light bulbs for monetary reasons (M = 3.76, SD = 1.80). Besides the liking of the light bulbs, we also found a significant effect of message type on perceived financial impact of switching lights off. As such, 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).

[4] When we excluded the participants who refused to change the light bulb, 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).

[5] Among the participants who refused to change the light bulbs (n = 10) we found a significant effect of message on environmental self-identity (F(1,8) = 12.18, p = .008, η_p^2 = .604).

2.5 Discussion

2.5.1 Implications of findings

At the start of this research we drafted 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 lights off in the second round of tasks) and at the end of the experimental session. We will elaborate upon our findings with respect to our expectations and add additional explanations where applicable.

We operationalized curtailment behavior in our experiment as switching lights off after completing a task in a room. Our results showed that after the light bulbs had been replaced, all participants either did not alter their curtailment behavior (when they replaced the light bulbs themselves for monetary reasons) or improved on their curtailment behavior (in all other conditions). This is not in line with our expectations from a licensing perspective, as we anticipated negative spillover effects for participants who had replaced the light bulbs themselves and no effect on curtailment behavior when the researcher had replaced the light bulbs. Our results are actually more in line with the hypotheses we based on self-identity and social norms theory. Specifically, we expected that the environmental message would be effective in terms of positive spillover to curtailment behavior. Our results show that, indeed, participants who received environmental information were more likely to switch the lights off in the second round as compared to the first round (for both the self and other condition). As noted, participants who replaced the light bulbs themselves for monetary reasons did not alter their behavior in the second round, which is also in line with our expectations. However, participants for whom the light bulbs were replaced by a researcher for monetary reasons were also more likely to switch the lights off in the second round, which is in contrast to our expectation. 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). As we did not have a baseline measure for switching the main light off at the end of the session, it is difficult to assess whether we actually observed positive or negative spillover. However, we could account for baseline differences in switching off behavior during the first round of tasks and look at the differences between the conditions. 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. When participants replaced the light bulbs themselves or when the researcher replaced the light bulbs for environmental reasons, we found that participants were equally likely to switch the light off at the end of the session. We, however, also expected that the environmental message condition would be more effective than the financial message condition. Although this is the case when the researcher replaced the light bulbs, we observed that participants who had replaced the light bulbs themselves for monetary reasons, they were as likely to switch the light off at the end of the session as participants in the environmental message condition. 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.

From a self-perception perspective, we expected that only participants' self-view would be changed when they had replaced the light bulbs themselves. We measured this with the environmental self-identity construct and 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 actually more 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.

2.5.2 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. 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. In terms of the switching off behavior during the tasks, we are rather certain that we observed positive spillover effects. Moreover, as we were mostly interested in the differences between the conditions, we are able to claim that when someone else makes an investment for monetary reasons this has the least positive effects on individual curtailment behavior when we measured it more implicitly at the end of the experimental session. In contrast to previous studies that often only measure intentions or place participants in

hypothetical situations, we were able to measure curtailment behavior in an objective manner. However, future research would 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.

Another defining feature of the set-up of our study was that participants did not pay for their energy use or the more energy-efficient light bulb. 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 and whether people still perceive themselves as being an environmentally-friendly person after the investment is made. It could be that when people invest actual money, they may adopt a cost-benefit mindset (Deci et al., 1999) and may not perceive their behavior as being particularly environmental.

2.5.3 Concluding remarks

This study was designed to investigate how an investment in an energy-efficiency measure influences subsequent curtailment behavior. We measured curtailment behavior right after the investment was made and found positive spillover effects for all conditions, and only those who had invested themselves for monetary reasons did not alter their behavior. As we were interested in how the investment in an energy-efficiency measure would affect curtailment behavior on a repeated basis, we included another measure of curtailment behavior at the end of the experimental session. Here we found that when a researcher replaced the light bulbs for monetary reasons, participants were the least likely to switch the lights off. This finding implies 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 of investments in energy-efficiency measures can have a positive effect on individual behavior. Moreover, our results suggest it to be best to focus on the environmental benefits of such an investment, as it will have positive effects on individual curtailment behavior. In case financial benefits should be highlighted, the best way forward would be to give people the feeling that they

could actively choose for this option, as this will increase how much they like the measure and are more likely to show pro-environmental curtailment behavior later on.

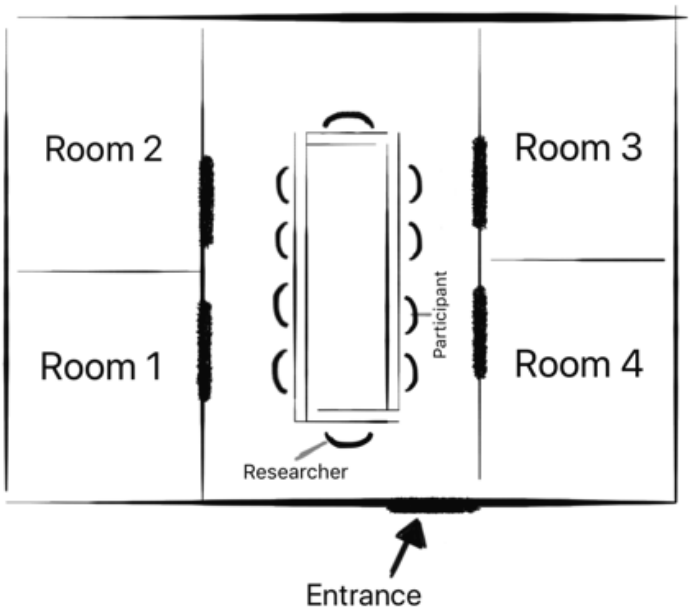
2.6 Acknowledgements

We would like to thank Shahzeen Attari for her valuable comments on an earlier version of this paper. This research was supported by a grant from the Social Sciences and Humanities Research Council of Canada.

2.7 Appendices

Appendix 1. Set-up of laboratory
Appendix 2. Tasks
Appendix 3. Experimental messages
Appendix 4. Time and performance on 10 tasks
Appendix 5. Light off after survey; 90% confidence intervals

Appendix 1
Set-up of laboratory

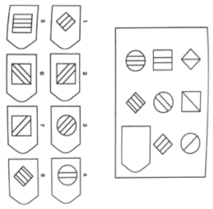


Appendix 2. Tasks

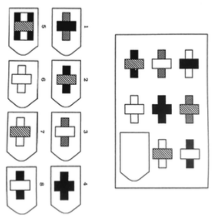
Randomly assigned to start with A-E or F-J in Round 1

TASK A ppt #:

Please identify the missing item that completes the pattern in the matrices below:



Your answer: ____



Your answer: _____

TASK B ppt #:

Please solve these math problems and return this sheet of paper to the researcher when you are finished.

Question	Answer
4 × 8	
7 × 9	
49 + 56	
9 × 11	
14 × 4	
16 – 4 + 14	
9 × 13	
4 + 20	
13 × 10	
4 × 8 – 5	
4 + 8	
2 × 17	
3 × 6	
6 × 15	
12 + 12	
3 × 3 × 3	
6 × 8	
5 × 5	
10 × 20	
11 × 12	

TASK C ppt #:

Please solve these math problems and return this sheet of paper to the researcher when you are finished.

Question	Answer
9 × 10	
7 + 7 – 7	
A.J. has three dimes, two nickels and one penny. How much money does he have?	
81 + 80	
74 – 58	
6 – 3	
30 – 20	
Four kids eat pizza. The pizza is divided into eight even slices. How many slices does each kid get to be even?	
28 – 19	
3 × 3	
6 + 8	
2 + 5	
8 / 1	
55 / 11	
17 × C = 34, C = ?	
17 – 8	
16 / 4	
Five cherries. You eat three. How many do you have left?	
A.J. has three pennies, two nickels and a dime. How much money does he have?	
Subtract nine from eighteen	
53 + 14	
8 + 3	

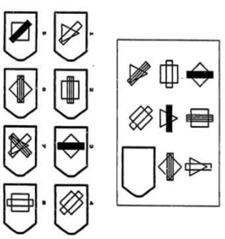
TASK D ppt #:

Please find **five of the words** on the right in the puzzle below and return this sheet of paper to the researcher when you are finished. Words can appear in reverse order, diagonally, horizontally and vertically.

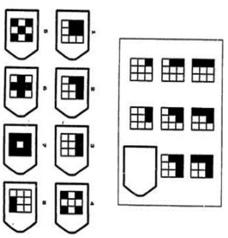
Y	S	E	I	O	I	C	H	E	E	T	A	H	A	BEAR
N	H	E	D	G	N	R	H	A	M	S	T	E	R	FISH
O	S	A	P	R	T	E	E	H	O	R	R	A	D	DINOSAUR
P	I	E	H	H	E	W	V	G	O	A	H	E	E	ZEBRA
O	F	L	V	C	R	O	W	A	D	A	A	W	G	AARDVARK
A	A	O	T	Z	I	L	B	H	R	A	E	V	O	ANT
B	N	M	E	A	E	R	B	E	S	R	B	N	H	BADGER
P	T	B	O	C	B	E	T	N	N	D	N	E	E	BAT
U	R	R	E	E	B	L	H	S	H	V	S	V	G	CHEETAH
A	O	R	G	A	L	E	E	D	O	A	L	R	D	CROCODILE
T	I	B	B	A	R	E	E	O	N	R	E	N	E	CROW
C	R	O	C	O	D	I	L	E	L	K	R	I	H	EEL
D	I	N	O	S	A	U	R	E	A	A	R	B	B	HEDGEHOG
A	R	O	E	E	S	T	A	T	E	A	H	O	I	HAMSTER
														MOLE
														OSTRICH
														PONY
														RABBIT
														RAVEN

TASK E ppt #:

Please identify the missing item that completes the pattern in the matrices below:



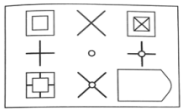
Your answer: _____

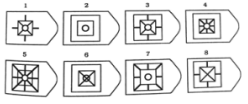


Your answer: ______

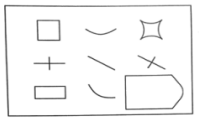
TASK F ppt #:

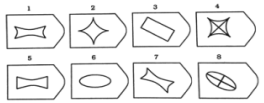
Please identify the missing item that completes the pattern in the matrices below:





Your answer: _____





Your answer: _____

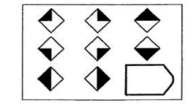
TASK H ppt #:

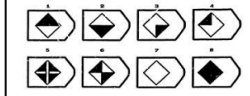
Please solve these math problems and return this sheet of paper to the researcher when you are finished.

Question	Answer
Joe ate three quarters of his orange. How many quarters does he have left?	
79 + 0	
B × 6 = 36, B = ?	
30 / 6	
6 × 9	
302 paintballs are in Bill's gun. If he fires half of them how many will he have left?	
17 – 17	
124897654 × 0	
8 + 9	
1 × 2 × 3	
4 + 4	
73 – 47	
Four birds on a fence. Three more come. How many birds?	
2.5 + 2.5	
8 – 5	
12 × 12	
121 / 11	
4 + 5 × 4	
24 / 6	
2 × 6	
Jake has four cats. Herb has two fewer cats than Jake. How many cats does Jake have?	
5 + 5 + 5	
7 × 12	
What is the area of a rectangle with sides of 3 and 8 inches long?	

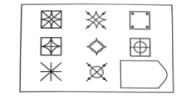
TASK J ppt #:

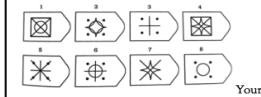
Please identify the missing item that completes the pattern in the matrices below:





Your answer: _____





Your answer: _____

TASK G ppt #:

Please solve these math problems and return this sheet of paper to the researcher when you are finished.

Question	Answer
265 + 185	
375 + 126	
281 + 109	
21 + 48	
216 + 289	
280 + 72	
55 + 396	
332 + 55	
41 + 217	
560 + 9	
33 + 502	
182 + 232	
215 + 153	
208 + 282	
157 + 119	
2 + 343	
44 + 369	
522 + 28	
407 + 65	
2 + 101	

TASK I ppt #:

Please find **five of the words** on the right in the puzzle below and return this sheet of paper to the researcher when you are finished. Words can appear in reverse order, diagonally, horizontally and vertically.

O	W	O	O	D	P	E	C	K	E	R	E	S	A
R	N	R	E	T	T	O	E	F	W	M	A	D	E
L	O	T	R	L	I	A	N	S	E	L	E	G	L
C	O	I	I	K	O	A	L	A	A	E	L	N	G
E	C	G	A	L	S	P	I	M	S	Y	A	K	A
S	C	E	O	U	E	E	A	L	E	E	E	P	E
O	A	R	B	N	D	N	H	A	L	N	I	A	A
O	R	Y	G	U	D	S	E	F	F	A	R	I	G
G	M	U	E	E	F	C	B	S	H	A	R	K	G
A	I	I	R	K	N	F	C	M	R	N	R	M	O
N	A	D	W	F	N	W	A	O	R	E	A	R	R
F	T	B	R	P	C	O	C	L	P	L	K	O	F
G	O	O	W	L	O	D	M	A	O	E	L	W	K
N	R	W	O	A	E	D	E	F	E	A	A	A	I

SNAIL
SALAMANDER
SHARK
TIGER
WEASEL
BUFFALO
WORM
WOODPECKER
YAK
RACCOON
PENGUIN
OTTER
OWL
MONKEY
KOALA
GIRAFFE
GOOSE
FROG
EAGLE

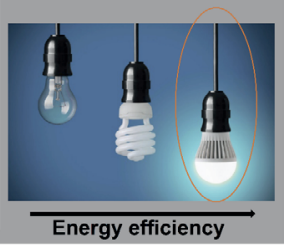
Appendix 3. Experimental messages

Self – Money

Here at UBC, we care about the money we spend. To minimize our financial expenses we closely watch our energy use.

In order to be able to reduce the energy we use in the lab we want to give you the opportunity to **switch to very energy-efficient LED lights** for the remainder of the experiment. All we ask from you is to change the less energy-efficient incandescent lights with LED lights in the different rooms before you start with the following round of tasks.

Please indicate whether you are willing to do this and return this paper to the researcher:
0 yes 0 no



Self – Environment

Here at UBC, we care about the environment. To minimize our impact on the environment we closely watch our energy use.

In order to be able to reduce the energy we use in the lab we want to give you the opportunity to **switch to very energy-efficient LED lights** for the remainder of the experiment. All we ask from you is to change the less energy-efficient incandescent lights with LED lights in the different rooms before you start with the following round of tasks.

Please indicate whether you are willing to do this and return this paper to the researcher:
0 yes 0 no

Other – Money

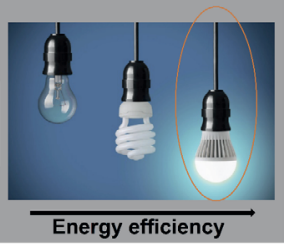
Here at UBC, we care about the money we spend. To minimize our financial expenses we closely watch our energy use.

In order to be able to reduce the energy we use in the lab we have decided to install **very energy-efficient LED lights** for the remainder of the study.

Other – Environment

Here at UBC, we care about the environment. To minimize our impact on the environment we closely watch our energy use.

In order to be able to reduce the energy we use in the lab we have decided to install **very energy-efficient LED lights** for the remainder of the study.



Appendix 4. Time and performance on 10 tasks

Due to the differences in tasks we expected differences in performance and duration for each specific task and were mostly interested in average performance and duration in the second round as compared to the first round. We, therefore, performed a repeated measures analysis of variance to detect the change in performance and time spent on tasks from Round 1 to Round 2 and we tested the effect of our 2×2 design. In Table 6 the means and standard deviations are depicted for the performance (in percentage correct) and time spent (in seconds) on each task as well as the average for both Round 1 and Round 2. The relation between time and performance was significant in Round 1, indicating a negative correlation (r =−.177, p = .013), indicating that those who took longer performed worse. In contrast, in Round 2, the association between performance and time was not significant (r =−.105, p = .143).

Table A4.1 *Mean performance and duration on tasks*

	Performance (% correct)		Duration (seconds)	
	Mean	*SD*	*Mean*	*SD*
First Round of Tasks				
Task 1	64.90	37.60	114.14	57.88
Task 2	96.06	5.25	153.96	69.12
Task 3	95.83	4.89	142.29	57.19
Task 4	99.20	4.75	144.14	85.08
Task 5	86.07	25.6	82.42	37.22
Average	89.34	12.6	127.39	34.54
Second Round of Tasks				
Task 6	64.90	36.58	95.06	41.29
Task 7	95.71	5.19	144.90	74.47
Task 8	96.14	4.89	128.62	49.20
Task 9	99.58	3.48	125.52	72.03
Task 10	80.71	29.60	84.11	65.16
Average	87.38	11.66	115.64	36.24

In terms of performance, we did not find a significant difference in performance from Round 1 to Round 2 ($F(1,194) = 1.73$, p = .190), nor did we find any significant interactions with round, in terms of who invested ($F(1,194) = 0.03$, p = .862), type of message ($F(1,194) = 0.62$, p = .431), or the interaction between who invested and type of message ($F(1,194) = 0.25$, p = .616).

For average time spent on the tasks between the two rounds, we found that participants were significantly faster in the second round ($F(1,194) = 21.77$, $p < .001$). However, similar to performance, we did not find any significant interactions between round and who invested ($F(1,194) = 0.59$, $p = .442$), type of message ($F(1,194) = 0.88$, $p = .348$), or the interaction between who invested and type of message ($F(1,194) = 0.32$, $p = .573$).

Appendix 5. Light off after survey; 90% confidence intervals

Table A5.1 *Odds of switching lights off as compared to the other conditions, while controlling for "baseline" switching off behavior with 90% confidence interval levels*

	Other-Environment		Other-Money		Self-Environment	
	Odds	90% CI	Odds	90% CI	Odds	90% CI
Other-Money	0.45	0.18-1.07				
Self-Environment	1.16	0.53-2.55	2.59	1.11-6.39		
Self-Money	1.34	0.62-2.95	3.00	1.29-7.38	1.16	0.54-2.48

Note. CI = Confidence Interval.

Chapter 3

Does your health trump our environment? Motivating hotel guests to save water

This chapter is based on Griffioen, A. M., Handgraaf, M. J. J., & Antonides, G. (*under review*). Does your health trump our environment? Motivating hotel guests to save water.

Abstract

Environmental problems are often regarded as distant, abstract issues that mostly concern other people. To stimulate pro-environmental behavior, campaigns often highlight benefits that are more personally relevant, in addition or instead of highlighting the environmental benefits. In order to study the effectiveness of messages, we categorized messages based on one psychological distance dimension: social distance. Across two studies we tested how people respond to messages on changing shower behavior at a hotel that highlight either health benefits (small social distance from oneself), environmental benefits (large social distance from oneself), or both benefits at the same time. Results from Study 1, an online survey study, indicated that indeed environmental benefits are seen as large in social distance and health benefits as small in social distance. Compared to the control condition, all participants in the experimental conditions were more willing to change their shower behavior. To test whether willingness to change also translated into actual behavior, we ran a field study (Study 2) to test the effectiveness of the same messages on objectively measured water use at a hotel. In terms of actual water use, the messages were not more effective than the control condition. However, how much participants valued the environment moderated the relation between the messages and actual water use; participants who did not value the environment very much were affected most by appeals that included health benefits (i.e., low social distance). These findings indicate that in a hotel setting, people who do not highly value the environment can be motivated to change their behavior, and behavior change is most likely when health benefits are highlighted.

Keywords: water conservation, psychological distance, construal level theory, hotel, net environmental impact

3.1 Introduction

Campaigns aimed at increasing pro-environmental behavior often highlight multiple benefits of such behavior at the same time (Chapter 4). Besides highlighting the obvious environmental benefits of acting in a more sustainable manner, appeals often also include personal benefits associated with the desired pro-environmental behavior (e.g., health or financial benefits). This is based on the assumption that targeting multiple motivations at the same time will have the largest impact on behavior across a broad range of individuals (Dietz et al., 2009). In other words, some people may be motivated to change their behavior for environmental reasons, whereas others are drawn by the personal, direct benefits. Even though combinations can be more effective (Abrahamse et al., 2005), previous research on pro-environmental behavior has shown that combined message appeals can sometimes backfire (e.g., Schwartz, Bruine de Bruin, Fischhoff, & Lave, 2015; van den Broek, Bolderdijk, & Steg, 2017).

One distinct difference between environmental benefits and other more direct, immediate benefits of pro-environmental behavior is that they differ in terms of how personally relevant such benefits are. One construct that captures this distinction is social distance, one of the four psychological distance dimensions (Trope & Liberman, 2010). Social distance can be defined as the distance between a person and others (Griffioen et al., 2016) and has been experimentally manipulated by focusing on the in-group vs. out-group (White, Johnson, & Kwan, 2014), making decisions for oneself vs. for someone else (Peng et al., 2013), targeting the self vs. an unfamiliar other (Liberman, Trope, McCrea, & Sherman, 2007), and power distance (Smith & Trope, 2006). In terms of benefits associated with pro-environmental behavior, when social distance is small the benefits are personally relevant (e.g., health and financial benefits), whereas large social distance would suggest that the benefits concern someone else or are not personally relevant (e.g., environmental benefits). Moreover, research on climate change perceptions has consistently shown that people regard climate change and the associated environmental consequences as distant on all psychological distance dimensions, including social distance (see Newell, McDonald, Brewer, & Hayes, 2014; Singh, Zwickle, Bruskotter, & Wilson, 2017).

In the current study we therefore differentiate message appeals based on the social distance of the highlighted benefits. Previous research has often compared financial with environmental appeals (Asensio & Delmas, 2015; Bolderdijk, Steg, et al., 2013; Schwartz et al., 2015; Steinhorst et al., 2015; van den Broek et al., 2017), but in these situations people often personally benefit from reducing their energy use regardless of the benefits communicated to them. In other words, when environmental benefits are

highlighted of reduced energy use, someone may still pay less on their energy bill when reducing their energy consumption. In order to really study the effectiveness of appeals that highlight either personal or more distant benefits it is valuable to study this in a situation in which financial benefits are absent. Moreover, there are ample situations in which financial benefits are not a concern; for example, at work (Handgraaf et al., 2013), when staying at a hotel, or paying all-inclusive rent (see Chapter 4). We, therefore, focus on another, often relevant, personal benefit of acting in a sustainable manner: Health benefits. In the current research we address one particular pro-environmental behavior: Reducing water use in the shower at a hotel. We focus on a hotel situation, as people have the tendency to use more water when staying at a hotel as compared to their normal shower behavior at home (Eurostat, 2009). We directly compare the effectiveness of appeals that highlight health benefits, environmental benefits, or both benefits at the same time in terms of reducing water use in a hotel room. Moreover, we explore the moderating effect of values, and in particular biospheric values, on the relation between the messages and energy conservation behavior.

3.1.1 Classification of messages

When comparing health and environmental messages, one clear difference lies in who gets to reap the benefits of the behavior change. Environmental benefits are experienced by society at large, whereas health benefits concern the individual who is engaged in the particular behavior. Naturally, one could argue that improved health has societal relevance, as medical costs will be minimized in the long-run, and that environmental issues also affect people at the individual level (e.g., costs associated with climate change adaptation). However, we argue and show that, even though these are valid considerations, environmental benefits are generally seen as something that is socially removed from individuals (Gifford et al., 2009; Leiserowitz, 2005; van der Linden, 2015), whereas health benefits are regarded as being more personally relevant. Both health and environmental benefits can be considered rather distant in terms of time, as both benefits will not materialize immediately. Nonetheless, health benefits are expected to materialize sooner as compared to environmental benefits, which underscores the relative more concrete (low construal level) nature of health benefits.

Therefore, we argue that environmental messages represent large social distance, whereas the associated social distance for health messages is small. Social distance is one of the four psychological distance dimensions, which include, next to social distance, spatial, temporal and hypothetical distance (Wakslak, Liberman, & Trope, 2007). Previous research suggests that psychological distance influences the level of

construal at which people process information. Specifically, the larger the psychological distance the more likely it is that people process the information at a high construal level. Construal level theory (Trope & Liberman, 2003) poses that people can process information, objects or events at different levels of abstraction. At a low construal level people think in very concrete, detail-specific terms, whereas at a high construal level people think in more abstract, distant terms. As health appeals are very personal and thus very close in terms of social distance, we argue that health appeals are processed at a low construal level. This is in line with earlier work by van Dam and van Trijp (2011), who show that health concerns mostly differ from environmental considerations in terms of the direct and personal benefits health concerns entail. In contrast, even though everyone may ultimately benefit from a better environment, people often regard the environment as something that is far removed from themselves which does not necessarily concern them personally (Klein, Hilbig, & Heck, 2017). We, therefore, argue that environmental benefits communicate benefits that are further removed from an individual (i.e., large social distance) and are thus processed at a high construal level. In sum, in the following we will refer to health appeals as low construal level and small social distance appeals, and to environmental appeals as high construal level and large social distance appeals.

3.1.2 Effect of construal level on target behavior

The level of abstraction at which people process information can influence behavior in a number of ways, as the decision processes involved with high and low construal level thinking differ. Previous research has found that communication of both low and high construal levels can be effective in stimulating pro-environmental behavior (see Griffioen, van Beek, Lindhout, & Handgraaf, 2016). When people think at a low construal level they are more susceptible to situational influences (Trope & Liberman, 2010) and feasibility concerns (Liberman & Trope, 1998). In contrast, when thinking at a high construal level, people are less influenced by situational factors and mostly guided by their inner values (Eyal, Sagristano, Trope, Liberman, & Chaiken, 2009) and desirability concerns (Fujita et al., 2008; Liberman & Trope, 1998). Therefore, when the situation itself promotes pro-environmental behavior, a low construal level may be effective, as people focus on the details and feasibility of the behavior in that particular situation. At the same time, a low construal level approach may be more problematic in situations that do not promote pro-environmental behavior, as individuals may have no reason to act in a pro-environmental manner and focus on potential barriers. Findings from previous research endorse this view, as financial appeals have been very effective in cases of

easy, one-off decisions (e.g., Gärling & Schuitema, 2007; Jakovcevic et al., 2014), but have been less useful in realizing long-term, behavior change (e.g., Asensio & Delmas, 2015; Bolderdijk, Steg, Geller, Lehman, & Postmes, 2013; Dogan, Bolderdijk, & Steg, 2014; Schwartz, Bruine de Bruin, Fischhoff, & Lave, 2015). When trying to stimulate long-term behavior change, high construal level appeals may be preferred, especially among those who strongly endorse environmental values, as behavior will be mostly guided by values and people will think of the desirable end state they want to reach. In the case of realizing short-term behavior change, we expect that low construal level messages will be more effective than high construal level messages.

3.1.3 Spillover behavior

Besides the effect that high and low construal level thinking has on a target behavior, it may also influence other (related) behaviors. This has been referred to as the "net environmental impact" (Truelove et al., 2014), which includes effects on related behavior (i.e., spillover; Thøgersen & Ölander, 2003) and the long-term effects of those behaviors. In terms of construal level, high construal level thinking may lead to the perception of links between different behaviors, which may lead to a consistent behavioral pattern across the board (Mullen & Monin, 2016). For example, Steinhorst, Klöckner, and Matthies (2015) showed that both environmental and financial framing of energy saving behavior affected the target behavior, but only the environmental framing led to positive spillover to other climate-friendly intentions. To the best of our knowledge, previous research has not found any positive spillover effects when low construal level manipulations or messages were used. Theoretically, this is not surprising, as low construal level thinking suggests that people will only focus on the specific behavior they are asked to perform and will not necessarily see the parallels with other pro-environmental behaviors.

3.1.4 Values and pro-environmental behavior

According to construal level theory, values guide behavior when people think at a high construal level (Brügger et al., 2015). Research on pro-environmental behavior has consistently shown that people who value the environment more, and thus score higher on biospheric values, show more pro-environmental intentions and behavior (Corner, Markowitz, & Pidgeon, 2014; Steg, de Groot, Dreijerink, Abrahamse, & Siero, 2011). On the one hand, this suggests that people who score high on biospheric values already portray a lot of pro-environmental behavior and are less able to change behavior (due to a "ceiling effect"). On the other hand, previous research shows that only people who strongly value the environment are susceptible to messages that relate

to the environment and are willing to change their behavior (Bolderdijk, Gorsira, et al., 2013; van den Broek et al., 2017). As it is yet unclear how values will specifically influence behavior, we will also explore the possible moderating function of biospheric values. Moreover, important to note is that biospheric values are not always directly related to behavior, and the relation between values and intentions tends to be much stronger than the relation between values and actual behavior (see Chapter 4). The fact that intentions and behavior are not aligned could be ascribed to the intention-behavior gap, which poses that intentions do not always directly translate into behavior, in turn stressing the need to study both intentions and behavior.

3.1.5 Single vs. combined construal level manipulations

A final aim of this research is to study whether messages that highlight multiple benefits at the same time are more or less effective than messages that highlight just one benefit. Two studies have compared the effectiveness of single message appeals (i.e., financial or environmental) with the combination of both appeals and found that the combination was less effective than the environmental appeal by itself when promoting an energy saving campaign (Schwartz, Bruine de Bruin, Fischhoff, & Lave, 2015) and searching for energy saving tips (van den Broek et al., 2017). We argue that this result can be due to the construal level at which people process messages. People can naturally shift between low and high construal level thinking (Wakslak et al., 2007), but only tend to process information at one construal level at a time, indicating that behavior is determined mostly by either the high construal level component or the low construal level component. It has been argued that in general low construal level thinking, which is more directly and readily available to individuals, may override high construal level considerations, and thus determine behavior (Fujita et al., 2013). Therefore, if the low construal level component is effective by itself, we would expect that the combination of high-construal and low-construal appeals are as effective as the low-construal appeal alone. However, when the low-construal appeal is not effective by itself, the combination of a high and low construal level appeal will most likely not be effective either.

3.2 Current research

In order to understand whether the construal level associated with different social distance appeals matters when trying to motivate people to change their behavior, we test how such appeals work in a hotel setting. We have chosen a hotel setting, as people are usually inclined to be less conscious about their energy use when on holidays and large reductions in energy use are therefore possible (Eurostat, 2009). In this study we focus on one particular energy behavior: taking showers. Taking a shower constitutes a large portion (18%) of total household energy use (as it requires a lot of energy to heat up the water; Tiefenbeck, Goette, Degen, & Tasic, 2016) and is a behavior that is under the direct control of individuals. For example, someone can easily decide to take a shorter or colder shower, which is in contrast to other (energy-intense) behaviors such as changing automated thermostat settings. Instead of focusing on financial benefits associated with reducing one's warm water use (which are absent in the hotel setting), we focused on the personal health benefits one could have when taking shorter and colder showers. Specifically, participants were told that taking long and hot showers could cause skin irritation and damage, something dermatologists have long agreed upon (Lazar & Lazar, 1991). We expect that the health appeal (small social distance and low construal level) is especially effective for hotel guests, as this situation has a rather short-term outlook. Moreover, we expect that an environmental appeal (large social distance and high construal level) is not effective in stimulating behavior change in this very short-term situation. This leads to *Hypothesis 1: A low construal level appeal is more effective in stimulating a reduction in warm water use among hotel guests than a high construal level appeal.*

Additionally, we investigate whether the combination of a high and low construal level appeal can be effective. Based on the premise that the low construal level benefit guides behavior when a high and low construal level appeal are combined, we expect that this combination is as effective as having a low construal level appeal in isolation. This leads to *Hypothesis 2: The combination of a high and low level of construal appeal is as effective as a low level of construal appeal by itself.*

Finally, we explore the possible moderating function of biospheric values on water use, as well as the spillover to other energy-related behavior (i.e., electricity use). To test our hypotheses, we ran two studies on the effect of the health and environmental messages on self-reported intentions (Study 1) and on objectively measured water use (Study 2). In Study 1, we tested the different messages and the possible moderating effect of values on the acceptability of different types of messages in a scenario experiment. Moreover, we asked participants how willing they would be to change

their behavior (i.e., taking shorter and colder showers). In Study 2 we tested the same messages with actual hotel guests. We installed detailed measurement equipment in individual hotel rooms, measuring warm water and electricity use. This way we are able to test whether the messages affect actual shower and energy use behavior.

3.3 Study 1

3.3.1 Method

Participants and design. 127 Participants (57 female, M_{age} = 34.65, SD_{age} = 10.19) were recruited using Amazon's Mechanical Turk and were asked to fill out a 10-minute survey via Qualtrics. Participants received $0.75 when completing the questionnaire. Participants were randomly assigned to conditions in a 2 (Health: message vs. no message) × 2 (Environment: message vs. no message) between-subjects design. Due to a technical issue, 27 participants skipped one question in the survey (regarding the highlighted benefits of the messages).

Procedure and measures. Upon opening the online survey, participants were informed that all information they provided would be treated anonymously and confidentially. All means and standard deviations for the self-report measures are depicted in Table 1.

In order to control for pre-existing individual differences in level of abstraction, participants were asked to rate 10 items from the Behavior Identification Form (BIF; Vallacher & Wegner, 1989). Participants were also asked to fill out the egoistic, hedonic, altruistic and biospheric items from Schwartz' value scale (1992) on a 9-point perceived importance scale (−1 = *opposed to my principles*, 0 = *not important*, 7 = *extremely important*; de Groot & Steg, 2008; Steg, Perlaviciute, van der Werff, & Lurvink, 2014). Participants were asked to fill out the value scale before they were exposed to the messages, to ensure that the messages did not influence their self-reported value scores. Thereafter, participants were randomly assigned to one of the four conditions. Specifically, participants were asked to imagine that they were staying at a hotel and at check-in they would receive a bar of soap with a message. The different types of messages can be found in Appendix 1. After viewing the message, we asked participants to rate their willingness to change their shower behavior in terms of duration and temperature on two items on a 7-point scale (1 = *not willing at all*, 7 = *very willing*). As an open-ended question, we also asked why they would (not) be willing to change their behavior. Additionally, participants were asked to rate items from Schultz's environmental concern scale (2001) on a 7-point scale (1 = *extremely unimportant*, 7 = *extremely important*) and were asked "To what extent does this message highlight benefits to…" (i.e., you, others, and society) on three items on a 7-point scale

(1 = *not at all*, 7 = *very much*). Finally, participants were asked to provide demographic information, were thanked for their participation, and given a personal completion code to receive their payment.

Table 1 *Means and Standard Deviations Study 1*

	Items	*Mean*	*SD*	*N*	*Reliability*
Behavior Identification Form	10	5.96	3.05	127	.834
Values					
Biospheric	4	4.55	2.08	127	.948
Altruistic	4	4.79	1.87	127	.904
Hedonic	3	4.29	1.82	127	.925
Egoistic	5	2.60	1.44	127	.759
Willingness to change	2	3.52	1.96	127	.847
Schultz values					
Biospheric	4	4.22	1.93	127	.961
Altruistic	4	4.54	1.96	127	.957
Egoistic	4	4.44	1.92	127	.921
Benefits					
Personal	1	5.07	1.94	100	
Collective	2	3.43	2.23	100	.918

Note. Reliability shows Cronbach's alpha for multi-item scales and the Spearman-Brown coefficient for two-item scales.

3.3.2 Results

We performed a linear regression with two dummy variables for health (0 = no health information, 1 = health information) and environment (0 = no environmental information, 1 = environmental information), respectively, on highlighted benefits and willingness to change. In all analyses we controlled for the effect of biospheric values and trait construal level (i.e., Behavior Identification Form; BIF). Additionally, we explored the potential moderating effect of both biospheric values and trait construal level. Finally, we studied the correlations between our self-report measures and our main outcome variables (i.e., highlighted benefits and willingness to change).

3.3.2.1 Highlighted benefits

As a manipulation check, we asked participants to indicate what type of benefits the message highlighted and used these items as a measure of social distance. A Principal Components Analysis revealed that the three items loaded on two

components, one component for benefits to self and one component for benefits to both others and society. We, therefore, averaged the scores for benefits to others and society, as a means of measuring large social distance, which we refer to as collective benefits.

Table 2 *Regression estimates for personal and collective benefits, and willingness to change (to take colder and shorter showers)*

	Highlighted benefits		
	Personal	Collective	Willingness to Change
Environment	−0.98 (0.43)*	3.92 (0.45)**	1.62 (0.41)**
Health	1.38 (0.44)**	1.11 (0.46)*	1.62 (0.48)**
Environment × Health	0.20 (0.62)	−2.17 (0.64)**	−1.37 (0.63)*
Biospheric values	0.34 (0.07)**	0.31 (0.08)**	0.37 (0.07)**
BIF	1.46 (0.49)**	0.49 (0.52)	1.20 (0.50)*
Constant	4.91 (0.30)**	1.51 (0.32)**	2.18 (0.33)**
Observations	100	100	127
R^2	0.378	0.511	0.288

Note. Standard Errors in brackets. ** $p < .001$, * $p < .05$

Table 2 shows the results from the two regression models with personal and collective benefits as the outcome measure, respectively. Participants who had seen the message which only contained environmental information indicated that this message highlighted collective benefits the most. Participants who received a message that contained health information indicated that the message highlighted personal benefits the most. When the message contained both health and environmental information, it significantly decreased the importance of collective benefits as compared to the environmental message condition ($B = -1.06$, $t(94) = -2.34$, $p = .022$). In contrast, receiving the combined message which contained both the environmental and health benefits did not significantly decrease the highlighted personal benefits as compared to the health message ($B = -0.79$, $t(94) = -1.79$, $p = .076$). These results thus indicate that the messages differentially highlighted personal and collective benefits (as depicted in Figure 1), and that the highlighted personal benefits remain equally important in the combined message.

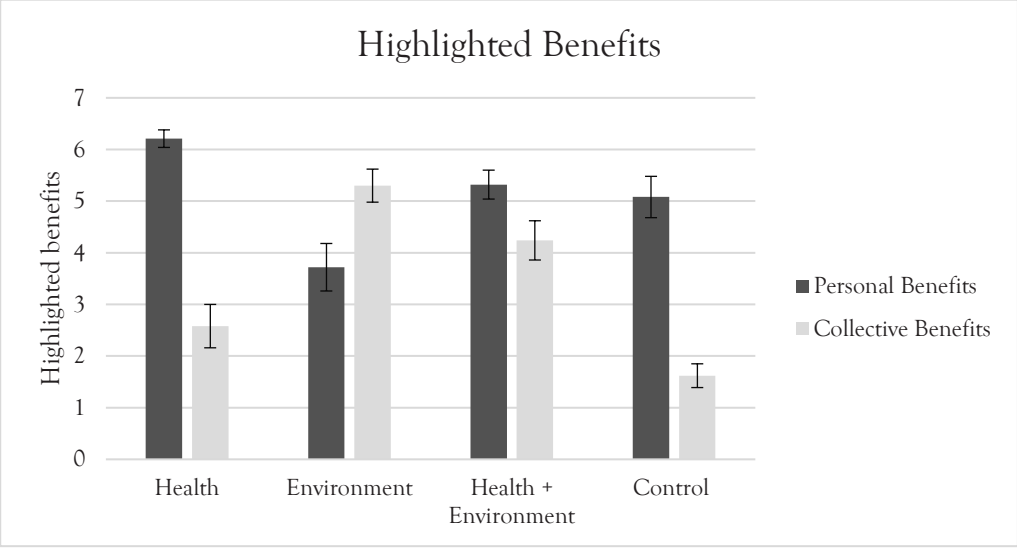


Figure 1 Highlighted personal and collective benefits per condition. Error bars represent ± 1 SE.

3.3.2.2 Willingness to change

Table 2 also shows the regression coefficients from the effect of the messages on willingness to change, while controlling for biospheric values and trait construal level (both mean-centered). The results indicated that participants who received messages containing health, environmental, or both health and environmental information were significantly more willing to change their shower behavior as compared to participants who received the control message. We, however, did not find significant differences between the message conditions that contained health, environmental or both environmental and health information in terms of willingness to change (see Figure 2; Health vs. Environmental message ($t(121) = 0.01$, $p = .996$), Health vs. Combined message ($t(121) = 0.24$, $p = .614$) and Environmental vs. Combined message ($t(121) = 0.24$, $p = .586$). This is not in line with our first hypothesis, stating that the low construal level message (i.e., the health message) would be more effective in stimulating the intention to change. Moreover, even though the combined message seemed to be as effective as both singular messages, we expected that this would be aligned with the low construal level message, and not with the high construal level (i.e., environmental) message.

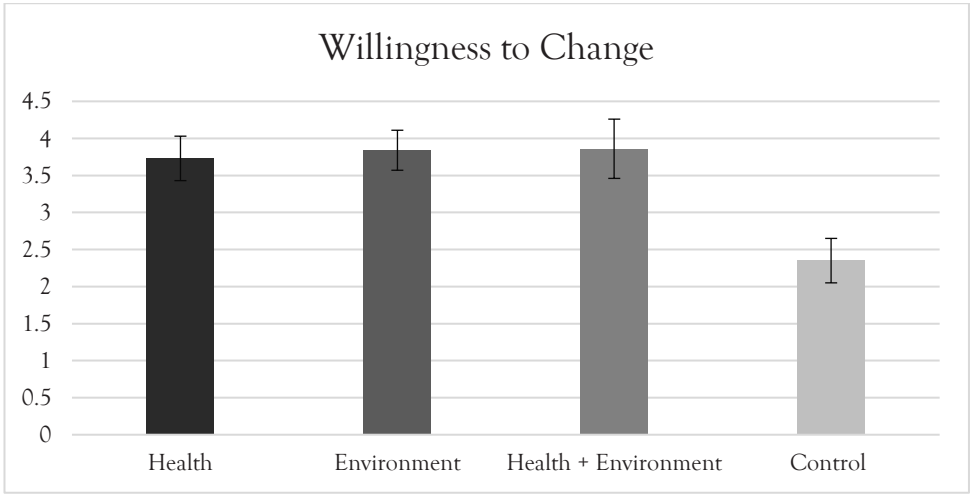


Figure 2 Willingness to change per experimental condition. Error bars represent ± 1 SE.

Participants who scored higher on biospheric values were also more willing to change their shower behavior. Similarly, participants who scored higher on the Behavior Identification Form, indicating that they tend to think at a higher construal level, were also more willing to change their shower behavior. We also looked at the potential moderating effect of both biospheric values and trait construal level but did not find that either construct moderated the relation between the experimental messages and willingness to change (see Table A2.2 in Appendix 2).

3.3.2.3 Correlations

As is clear from the analyses above, biospheric values are related to willingness to change, but also to the type of benefits that were highlighted (see Table A2.1 in Appendix 2 for correlations). Similarly, altruistic values portrayed the same pattern as biospheric values in terms of their relation to willingness to change and the benefits that were highlighted in the messages. These results indicated that those who scored higher on self-transcendent values (i.e., altruistic and biospheric values) were more willing to change their behavior and also indicated that they thought the associated benefits with the behavior change (i.e., taking shorter and colder showers) were larger. Finally, both personal and collective benefits were positively associated with willingness to change; this correlation indicated that when participants saw more benefits in changing their shower behavior, they were more willing to change their behavior.

3.3.3 Discussion

Results from Study 1 showed that indeed environmental messages highlight collective benefits the most and health messages highlight personal benefits the most. The combined health and environmental message falls in between the single message constructs in terms of the highlighted benefits. When both benefits were highlighted at the same time, participants rated the personal benefits to be highlighted more than the collective benefits, suggesting that the personal (health) information carried more weight when deciding based on the combined message. Additionally, this study showed that participants did not necessarily think about either clear personal or collective benefits, when they received either the environmental or health message in isolation, respectively. For example, when participants were asked to take shorter showers for health reasons, they did not automatically think about the environmental repercussions of their behavior. Interestingly, in the control condition, personal benefits were also rather high, which we believe is due to the fact that participants are told that they receive a bar of soap, which obviously has some personal benefit (i.e., they receive a gift).

When participants were asked about their willingness to change their behavior (by taking shorter or colder showers), in all experimental conditions they were more willing to change their behavior as compared to the control condition. We did not find any differences between the different message types, which suggests that there were no differences between our social distance manipulations. This is contrary to our hypotheses, as we expected that the health messages (small social distance) would be most effective. Moreover, this also suggests that there are no clear differences between single and combined messages, as all experimental messages seemed equally successful in increasing willingness to change participants' shower behavior compared to the control condition. We did, however, find that people who scored higher on biospheric values were more willing to change their behavior, irrespective of the type of message they received. Of course, self-reported willingness to change behavior is not the same as actual behavior change. To be able to test the effectiveness of differently framed messages on actual behavior change, measures of actual behavior are needed beyond the self-reported willingness to change measure used in this study.

3.4 Study 2

In Study 2 we, therefore, tested the effectiveness of the same messages on objectively measured water use in the shower at a hotel located in The Netherlands. Guests usually stay for a couple of nights at this hotel and we examined the first day of their stay in order to have the same information for all guests. We expected that the messages containing health information (both the single health message and the combined health and environmental message) would be most effective. We also explored the possible moderating effect of biospheric values and the possible spillover to electricity use during the guests' stay.

3.4.1 Method

Participants and design. 118 participants were recruited based on the rooms they were staying in (response rate: 90.77%). 5 participants were excluded from the analysis, as these guests ended up staying in rooms without measurement equipment. The reception personnel asked hotel guests after check-in whether they would be willing to participate in a short study, by completing a short survey. This resulted in 113 participants (M_{age} = 30.58, SD_{age} = 11.91, 49.56% female) who were randomly assigned to conditions in a 2 (Environment: message vs. no message) × 2 (Health: message vs. no message) between-subjects design.

Procedure. Upon agreeing to participate, participants were asked to fill out a 2-page paper-and-pencil survey (either in Dutch or in English). In case two people were staying in the hotel room, one of the guests was asked to fill out the survey. Participants first read the informed-consent part and subsequently answered a number of questions. We included questions on the importance of different aspects when choosing a hotel, their average shower time at home and their shower behavior at a hotel, items from the Portrait Value Questionnaire (Schwartz et al., 2001), and demographic questions (e.g., age, gender, nationality). After completing the survey, participants received a small container of shower gel[6] with the experimental message printed on a slip of paper attached to the package.

Experimental manipulations. The messages that were tested in Study 1 were used again in Study 2, with minor adjustments. Appendix 3 shows the exact messages for all conditions.

[6] We have chosen shower gel in the field study based on the available options of soap and the potential waste of providing participants with a full bar of soap

Objective measures of energy use. To test the effectiveness of the different messages, we measured the electricity and water use in the individual hotel rooms for all participants. We used the aggregate use of water and electricity from the moment of check-in until 12 o'clock the next morning (i.e., check-out time[7]). In terms of water use, we detected outliers as those values that were greater than 1.5 times the interquartile range (IQR; Q3 – Q1) above the third quartile (Cohen, Cohen, West, & Aiken, 2003). We replaced outliers (N = 6) with the value 1.5 times IQR above the third quartile. For electricity use, we calculated the average electricity use for the hours present in the room and detected and replaced outliers (10 outliers for socket use and 10 outliers for light use) similar to the water use data.

Materials.

Informed consent. Participants were first asked to read the informed-consent form, in which it was stated that participation in this research was voluntary and that participants were allowed to withdraw from this study at any time without penalty. Moreover, it was explicitly stated that we measured the individual warm water and electricity use in the rooms and that this data was going to be related to the answers in the survey. All means of the self-reported measures are reported in Table 3.

Criteria for hotel choice. We asked participants to rate the importance of "Price," "Sustainability," "(Online) reviews," and "Stars" on a 7-point importance scale (1 = *not important at all*, 7 = *very important*).

Shower behavior. Participants were then asked to indicate their average shower duration at home in minutes. Additionally, we asked participants to what extent they shower shorter or longer when staying at a hotel as compared to when they shower at home on a 7-point scale (1 = *a lot shorter*, 7 = *a lot longer*).

Values. We included items from the Portrait Value Questionnaire (PVQ; Schwartz et al., 2001). Compared to the original value scale by Schwartz (1992), the PVQ is less abstract and thus easier to understand for people with different backgrounds. Participants were asked to "read each description and think about how much each person is or is not like you" on a 6-point scale (1 = *not like me at all*, 6 = *very much like me*). We constructed two versions, one female and one male version. We included two items on biospheric values (e.g., "She thinks that people should care for nature. Looking after the environment is important to her"), two items on altruistic values (e.g., "It's very important to her to help the people around her. She wants to care for other people"), two items on hedonic values (e.g., "She seeks every chance she can to

[7] We could unfortunately not account for the water used by the cleaning personnel – we do assume that this is randomly distributed across all rooms.

have fun. It is important to her to do things that give her pleasure"), and four items on egoistic values (e.g., "It is important to her to be rich. She wants to have a lot of money and expensive things").

Demographics. Finally, we asked participants to report their gender, age and nationality (29% Dutch, 25% German, 6% French, 5% British, 5% Chinese, 5% Spanish, 25% Other). Moreover, we also asked for the purpose of their stay at the hotel, as well as whom they were staying with at the hotel (i.e., "Alone" (N = 36), "My partner" (N = 46) "A friend" (N = 17) or "Other" (N = 12)).

Table 3 *Means, standard deviations, sample size, and reliability for self-report measures.*

Self-report measures	Items	*Mean*	*SD*	*n*	*Reliability*
Criteria for choosing a hotel					
Price	1	5.64	1.33	113	
Sustainability	1	4.50	1.54	111	
Reviews	1	5.31	1.46	109	
Stars	1	3.98	1.36	111	
Average self-reported shower time	1	10.94	7.58	113	
Deviation of shower time in hotel from home	1	4.27	0.96	113	
Values					
Biospheric	2	4.26	1.08	111	.648
Altruistic	2	4.73	0.80	111	.350
Hedonic	2	4.08	1.02	110	.551
Egoistic	4	3.20	0.95	110	.723

Note. Reliability shows Cronbach's alpha for multi-item scales and the Spearman-Brown coefficient for two-item scales.

3.4.2 Results

Similar to Study 1, we conducted a linear regression analysis to detect the effect of the messages on objectively measured water and energy use, our main dependent variables of interest. Specifically, we tested the effect of messages containing health (0 = no health information, 1 = health information) and environmental (0 = no environmental information, 1 = environmental information) information. Moreover, biospheric values were included in the analyses as a covariate and as a moderating variable (in both cases mean-centered). In the final part of the results section we discuss the correlations between the self-report measures and the objective measures of water and electricity use.

3.4.2.1 Water use

Table 4 provides the estimates from the linear regression with objectively measured water use as the outcome variable. The analysis showed that the messages itself did not have a significant effect on how much water participants used during the first night of their stay. Biospheric values did have a main effect on water use, showing that participants who scored higher on biospheric values used less water. Moreover, biospheric values moderated the relation between the messages and water use. Specifically, when participants received a message that contained health information, participants who scored lower on biospheric values were especially receptive to this message in terms of their total water use. As such, participants in the health message condition, who scored lower on biospheric values used less water than participants who scored higher on biospheric values. In all analyses we controlled for the number of people in the room (0 = alone, 1 = together), and as expected, participants who stayed with two people in the room used more water[8].

Table 4 *Regression coefficients for water use in liters (with and without biospheric values as moderator)*

	Water use	
	Model 1	Model 2
Environment	6.57 (6.67)	3.73 (6.69)
Health	3.74 (6.61)	1.72 (6.71)
Environment × Health	−8.21 (8.91)	−6.73 (8.90)
# of people in room	9.73 (4.80)*	10.17 (4.77)*
Bio		−12.38 (5.69)*
Bio × Environment		8.43 (6.70)
Bio × Health		16.81 (6.87)*
Bio × Health × Environment		−7.93 (8.76)
Constant	27.60 (5.53)**	30.47 (5.60)**
Observations	110	110
R^2	0.052	0.127

Note. Bio = self-reported biospheric values; ** $p < .001$, * $p < .05$

[8] Number of people who stayed in the room did not moderate the relation between the experimental messages and water use.

3.4.2.2 Spillover to electricity use

To explore possible spillover effects to electricity use, we conducted a regression for both the light use and socket use, again, with and without biospheric values as a moderating variable. In terms of spillover to electricity use (in terms of light and socket use), the results presented in Table 5 indicate that the messages did not have significant effects on electricity use. Moreover, we found no interaction with biospheric values on objectively measured electricity use.

Table 5 *Regression coefficients for light and socket use in Watt hour (with and without biospheric values as moderator)*

	Light use		Socket use	
	Model 1	Model 2	Model 1	Model 2
Environment	−2.01 (2.39)	−3.04 (2.46)	−1.95 (2.48)	−1.57 (2.54)
Health	1.23 (2.36)	0.55 (2.46)	−0.20 (2.45)	0.37 (2.53)
Environment × Health	−0.64 (3.17)	0.01 (3.24)	0.61 (3.31)	0.08 (3.37)
# of people in room	−3.20 (1.70)	−2.75 (1.72)	0.49 (1.78)	−0.16 (1.81)
Bio		−2.92 (2.11)		0.65 (2.15)
Bio × Environment		4.09 (2.52)		0.22 (2.59)
Bio × Health		4.46 (2.46)		−2.59 (2.53)
Bio × Health × Environment		−4.00 (3.19)		−0.51 (3.31)
Constant	16.15 (2.01)**	16.80 (2.11)**	17.35 (2.05)**	17.50 (2.11)**
Observations	108	108	109	109
R^2	0.057	0.105	0.010	0.052

Note. Bio = self-reported biospheric values; ** $p < .001$, * $p < .05$

3.4.2.3 Exploratory analyses

In Table 6 we report the correlations between the different self-report measures and objective measures. In terms of the correlations between the objective measures of energy use, we found that water use correlated with light use, but not with socket use. This thus indicated that people were somewhat consistent in their energy use behavior, as those who used more water were also more likely to use more electricity in terms of light. In terms of correlations between self-reported shower time and objectively measured energy use, we found a significant correlation with all the objectively measured energy use variables (i.e., water and electricity). This result indicated that the self-reported shower time at home corresponded to their actual water use at the hotel. Moreover, people who indicated to take longer (shorter) showers at home also used more (less) electricity in terms of light and socket use.

Additionally, when participants indicated that sustainability was an important criterion when choosing a hotel, they also indicated to shower shorter at a hotel as compared to how long they showered at home. This also suggests that those who did not choose a hotel for sustainability reasons, were more likely to take longer showers at a hotel as compared to how long they would usually shower at home.

Finally, we found significant correlations between biospheric values, shower time at home and how much the duration of participants' shower differed at a hotel setting from their home situation. This correlation indicated that the more people value the environment, the shorter they shower at home. Moreover, we found a negative correlation between biospheric values and shower duration at a hotel, which suggests that whether participants are inclined to take longer showers when staying at a hotel is related to how much they care about the environment. In other words, when someone indicated to not care a lot about the environment, it was more likely that this person indicated to take longer showers when staying at a hotel (as compared to the normal showers at home). This again stresses the need to focus on individuals who usually do not think about the environmental consequences of their behavior, as they represent a group that can still reduce and change their current behavior to a large extent.

Table 6 *Correlations between objective measures and self-report measures*

	Objective measures			Self-report measures									
	Water	Light	Sockets	Price	Sustainability	Reviews	Stars	Biospheric	Altruistic	Hedonic	Egoistic	Shower time	Hotel shower
Light	.512***	-	-	-	-	-	-	-	-	-	-	-	-
Sockets	.105	.305**	-	-	-	-	-	-	-	-	-	-	-
Price	.030	.063	−.007	-	-	-	-	-	-	-	-	-	-
Sustainability	−.012	.078	.050	.121	-	-	-	-	-	-	-	-	-
Reviews	.079	.113	.076	.352***	.031	-	-	-	-	-	-	-	-
Stars	.092	.039	.060	−.067	−.011	.171*	-	-	-	-	-	-	-
Biospheric	−.058	.126	−.111	.014	.371***	.003	−.105	-	-	-	-	-	-
Altruistic	−.085	−.230**	.201**	.102	.192**	.056	.053	.415***	-	-	-	-	-
Hedonic	.089	.071	.008	−.151	−.157	.041	.068	−.074	.131	-	-	-	-
Egoistic	.015	.066	.034	−.051	−.204***	.004	.296**	−.016	−.082	.476***	-	-	-
Shower time	.479***	.180*	.203**	.066	.105	.036	.201**	−.217**	−.023	.068	.107	-	-
Hotel shower	.077	−.043	−.088	.016	−.271**	.118	.126	−.234**	−.121	.123	.255**	.130	-
Age	−.118	.008	−.021	−.168*	.022	−.087	.001	.062	−.012	−.327***	−.337***	−.263**	−.236**

Note. * $p < .10$, ** $p < .05$, *** $p < .01$

3.4.3 Discussion

We hypothesized that the health manipulation (small social distance and low construal level) would be most effective (Hypothesis 1) and that the combined message would be as effective as the health manipulation (Hypothesis 2) for reducing water consumption. In Study 2 we found no direct effects of the experimental messages on warm water use, which indicated that a message by itself was not effective in changing the objectively measured warm water use behavior. However, we did find that biospheric values moderated the effect of the health messages on warm water use. In terms of water use, participants who scored lower on biospheric values were mostly influenced by the health messages. This is an important finding, as people who score lower on biospheric values are usually the ones that do not already engage in a lot of pro-environmental behavior (Steg & de Groot, 2012), which means that there is a lot to gain in this group. This is also reflected in the main effect of biospheric values on water use, as participants who scored lower on biospheric values used more water than those who scored higher on biospheric values.

Finally, in terms of spillover effects, we did not find any spillover effects to electricity use. This can be due to a number of factors. Electricity use very much depends on how long someone is in the room and what kind of activity he or she is doing (e.g., working on a laptop, watching TV, or reading a book). Moreover, we expected that the low construal level appeal (i.e., health message) would be more effective in stimulating a reduction in water use. However, we also anticipated that spillover is only likely in the high construal level condition (i.e., environmental message), as it will enable people to think about the similarities between different types of behaviors (see Chapter 4). Not surprisingly, when the high construal level message does not successfully change water use, it is unlikely that reading the environmental message will result in either positive or negative spillover to other related energy-use activities.

3.5 General discussion

3.5.1 Implications of findings

The aim of this research was to study the effectiveness of messages that either highlight a low construal level (or small social distance) benefit, a high construal level (or large social distance) benefit or both benefits at the same time in the absence of financial benefits. We hypothesized that especially the health message (i.e., small social distance and low construal level) would be effective in stimulating water conservation behavior (Hypothesis 1). Results from Study 1 show that all experimental messages

were effective compared to the control condition in terms of people's self-reported willingness to change shower behavior. We did not find any differences between the experimental conditions. In contrast to the apparent effectiveness of all messages, Study 2 indicated that the messages did not have a significant effect on the objectively measured warm water use, which is in line with work on the "intention-behavior" gap (e.g., Webb & Sheeran, 2006). We did, however, find that biospheric values moderated the relationship between the messages and water use. Notably, the health messages were especially appealing to those who scored lower on biospheric values (i.e., those caring less about the environment), whereas those who scored higher on biospheric values were generally unaffected by messages (irrespective of the type of information those messages contained). More importantly, the health information proved to be effective among a group of people who may otherwise not be affected by manipulations that solely focus on environmental benefits. As such, when people do not care for the environment, high construal level appeals will likely not lead to the intended effect, as people may be motivated to act upon their values and their values will probably not point in an environmentally-friendly direction. Moreover, our self-report measures show that the lower people value the environment the more likely they are to take longer showers at home and even longer showers when staying at a hotel. The association between values and self-reported behavior thus suggests that people who score lower on biospheric values are a worthwhile group to target as they still have more room for improvement.

When people indicated to care a great deal about the environment, we did not find any differences between the different message appeals and the control condition. This may indicate that those who value the environment to a great extent may be generally less influenced by messages that focus on any form of pro-environmental behavior. This can be due to a so-called "ceiling effect," which suggests that they are already acting in a pro-environmental manner and there is not a lot of room for improvement. As has been suggested in previous work, how much people value the environment is an important indicator of how much people already engage in pro-environmental behavior (Steg & Vlek, 2009). We find support for this reasoning, as the effect of biospheric values on water use showed that the higher people scored on biospheric values the less warm water they used. In addition to the association between biospheric values and current behavior, previous studies also suggest that people act more upon their inner values when they think at a high construal level (Giacomantonio et al., 2010). This would imply that when participants read a high construal level message, they are more inclined to act upon their values, which would make the high construal level message the most effective among those who score

higher on biospheric values. Our studies are not in line with this reasoning, as people in the high construal level condition (i.e., environmental information) who scored higher on biospheric values were not more willing to change their shower behavior (Study 1) or use significantly less water (Study 2). To explain this discrepancy, we pose that the situation influences how people make decisions and behave, which may in turn determine whether a high or low construal level is effective. In our specific experimental situation (i.e., a hotel) the low construal level appeal (i.e., health information) may have been effective because of the rather short-term outlook of this situation. Although the low construal level message was not effective among all participants, in this particular situation it could be the best option at hand, as it will at least motivate a specific group of people to change their behavior. Additionally, when clear personal (financial) benefits are lacking in such situations it does seem to pay off to focus on other concrete, personal benefits.

Our second hypothesis concerned the effectiveness of the combined message as compared to the single messages. We expected that the combined message (i.e., including health and environmental information) would be as effective as the health message alone. Both studies reveal no differences between the experimental conditions. However, again, when we accounted for differences in biospheric values, we found that biospheric values moderate the relation between the health messages and objectively measured warm water use. This showed that, in line with our hypothesis, the single health message and the combined message (i.e., health and environmental information) were equally effective. We argue that this effect is driven by the low construal level component (i.e., health information) and thus not by the high construal level information (i.e., environmental information). Previous studies on interventions that combined construal level manipulations with another construct, consistently show that the two constructs should be aligned (Chang et al., 2015; Goldsmith et al., 2016; White et al., 2011). These studies did not look at the effectiveness of single construal level manipulations in comparison to combined intervention approaches. Our study thus adds to these existing studies, by showing that a combined message that is not aligned in terms of construal level can reduce water use as long as the low construal level appeal drives the behavior change. Although we could not find any significant differences between the experimental conditions in terms of willingness to change in Study 1, we did assess the type of benefits the messages highlighted. Specifically, for the combined message appeal, we found that participants rated the personal benefits higher than the collective benefits. This suggests that, indeed, personal benefits may be more important in the combined message appeal and that the collective benefits are devalued because of the additional

information. Previous research has also suggested this, as low construal level information is more directly available to people as compared to the high construal level appeal (Fujita et al., 2013), this information may thus be more important for whether people are willing to change their behavior. In contrast, when the high construal level message is effective in realizing behavior change and the low construal level message is not, combining this message with a low construal level message will make people focus on the low construal level information and are thus unlikely to change. This theorizing is supported by previous findings on combined messages containing both financial (i.e., low construal level appeal) and environmental information (i.e., a high construal level appeal). Specifically, when the environmental message was effective, combining this message with a financial appeal was not effective (Schwartz et al., 2015). Our current finding thus adds to previous findings by showing that when a low construal level manipulation is effective by itself, combining it with a high construal level appeal is not more effective, but is at least not ineffective. Moreover, research on the effectiveness of single construal level manipulations on pro-environmental behavior remains limited, especially in more applied settings, and this study also adds to our understanding of how such relatively simple messages may work in the field.

Finally, we did not find any evidence for spillover to other energy-related behaviors. We did not postulate any specific hypotheses for possible spillover effects to electricity use, but the fact that we have a null result may indicate that spillover is unlikely in such a short time-span. In line with our finding, previous research has shown that environmental messages can lead to positive spillover, whereas self-interest appeals are unlikely to lead to positive spillover (Evans et al., 2013; Steinhorst et al., 2015). When we compare the current findings with previous work that has focused on appealing to environmental and health benefits, but also research on financial benefits, our findings are mostly in line with this body of work. As such, when short-term, one-off decisions are targeted, highlighting the very direct, personal and thus low construal level benefits of behavior has been effective (e.g., Jakovcevic et al., 2014). Moreover, previous research has found that messages are more persuasive when they are aligned with people's values (van den Broek et al., 2017). From a construal level perspective this again highlights that the messages or other types of interventions should be in line with the decision frame or situation. This also explains why environmental appeals have proven to be effective in studies that focus on long-term behavior or long-term benefits (e.g., Schwartz et al., 2015). In our studies, participants were in a rather short-term situation and received a bar of soap or shower gel, which

is probably more aligned with low construal level thinking than with high construal level thinking.

3.5.2 Limitations and future research

The very unique feature of the current study is that we could measure the actual water and electricity use in individual hotel rooms, which is very different from earlier studies carried out at hotels which have mostly focused on the reuse of towels (Baca-Motes et al., 2012; Goldstein, Cialdini, & Griskevicius, 2008). Similar to previous work, however, is that we did not distinguish between guests who stayed by themselves or with someone else, something that should be explored further. It may well be that people who share a room feel more inclined to reduce their shower time after receiving a message to maintain a positive image to the person they are staying with. Moreover, and importantly, the differing results between Study 1 and Study 2 underscore the importance of having objective measures of behavior next to self-reported intentions. Based on the results of Study 1 alone, we could have falsely concluded that any message containing a reason to change behavior is effective and that it does not necessarily matter whether it is a single or combined message. The results from Study 2 clearly give nuance to this finding, by showing that messages by itself may not be very effective in changing behavior, but that there are differences between the effectiveness of the type of messages when personal differences in values are considered.

In this research we classified the health message as a low construal level manipulation, because of the small social distance component. We tried to ascertain by asking people what kind of benefits were highlighted by both messages in Study 1, to ensure that the messages indeed influenced social distance. Another component that is involved in the health message may be the novelty of the information that is provided to hotel guests. Nowadays, many hotels communicate about their environmental impact, and usually ask guests to reuse their towels. Therefore, guests may not be as strongly affected by the environmental information as they may be accustomed to this type of information in a hotel setting. At the same time, we suppose that hotel guests do not automatically associate shower behavior at a hotel with its environmental impact. Indeed, when participants were asked about the type of benefits the different messages highlighted, participants did not indicate that collective benefits may also be important when they read the single health message. This, thus, suggests that people will not automatically consider the environmental consequences of their shower behavior at a hotel. Nonetheless, the familiarity of receiving environmental information when staying at a hotel may have influenced the

actual (in)effectiveness of the appeals. The health message, especially in case of the skin issues related to long and hot showers, is more novel and is not a common message used in hotels. Moreover, we did not test whether people thought the health message was credible (e.g., whether they believed in the harmful effects of showers on their skin). However, in Study 1 we did ask whether people would be willing to change their behavior, and in case people thought the message was not credible at all, we should have observed that they would not be willing to change their behavior. Whether the novelty of the health message actually added to the effectiveness of health messages among those who scored lower on biospheric values should be explored further. Future research should investigate whether less novel, low construal level information is equally effective.

In both studies we specifically targeted (hot) water use when staying at a hotel, and it should be studied how the manipulations would work when people are in a different context. If indeed the context is very influential on the effectiveness of different messages, it should be studied how such messages (or other construal level messages) would work when people are staying somewhere for a longer period of time. We anticipate that in long-term situations low construal level appeals will be less effective than high construal level appeals, due to the nature of the targeted behavior and the situation. Moreover, future studies should also detect how other types of construal level manipulations play out across situations.

Across both studies our results could have been influenced by social desirability concerns and demand effects. In Study 1, social desirability may partially explain why all participants indicated to be willing to change their shower behavior after receiving a message prompting them to do so. In order to address this issue, we used objective measures of water use in Study 2. However, as participants were aware of being monitored, everyone who participated in the study may have already used less water because of this notion. In the current study we cannot tease apart which share of the energy savings are due to monitoring or due to our messages. Yet, as we were interested in the differences between the conditions, and everyone was equally aware of being monitored and we had a control condition in which participants did not receive a message informing them on the negative consequences of long and hot showers, we believe that our results stand, and that this in fact provides a conservative test of our ideas. Future research could address whether being monitored has a direct influence on behavior and how this interacts with different intervention approaches.

Finally, previous studies have often targeted behavior that also somehow benefits participants personally and most often in financial terms (e.g., lower energy bills, gas bills). In our two studies, people did not benefit financially from saving water, as the

only one who would benefit from lower water use financially is the hotel. As our manipulations were only effective among people who scored lower on biospheric values, it may well be that the effectiveness of the same manipulations would play out differently if people were to financially benefit from their behavior change. Future research could address this issue by specifically studying the effectiveness of interventions in situations in which people do not personally benefit from reducing their energy use and compare it to situations in which people do pay for their energy bill, and thus benefit financially from changing their behavior.

3.5.3 Concluding remarks

The aim of the current research was to assess the effectiveness of construal level messages on shower behavior at a hotel. We expected that the low construal level manipulation would be especially effective in a short-term situation such as the hotel setting we studied and found that this was only the case among participants who indicated to care less about the environment. This is an important finding, as it is generally assumed that people who do not care about the environment are unlikely to already act in a pro-environmental manner or willing to change their current behavior. Participants who indicated to care a great deal about the environment were not affected by the different message appeals. Therefore, the most important finding from this research is that more direct, personal benefits (i.e., low construal level) of pro-environmental behavior can be highlighted to motivate a group of people who would otherwise be unlikely to act in a sustainable manner.

3.6 Acknowledgements

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3.7 Appendices

Appendix 1. Messages Study 1
Appendix 2. Additional analyses Study 1
Appendix 3. Messages Study 2

Appendix 1. Messages Study 1

Health information:

Enjoy this lovely PH neutral soap!

Did you know that taking long and hot showers is actually quite damaging to your skin? By taking shorter and colder showers you can prevent dry skin and other skin irritations.

Environmental information:

Enjoy this lovely eco-friendly soap!

Did you know that taking long and hot showers is actually quite damaging to the environment? By taking shorter and colder showers you do not only reduce your water use, but you also save the energy that is needed to heat up the water.

Health and Environmental information combined:

Enjoy this lovely PH neutral and eco-friendly soap!

Did you know that taking long and hot showers is actually quite damaging to the environment and to your skin? By taking shorter and colder showers you do not only reduce your water use, but you also save the energy that is needed to heat up the water and you can prevent dry skin and other skin irritations.

Control:

Enjoy this lovely soap!

Appendix 2. Additional analyses Study 1

Table A2.1 *Correlations between main dependent measures and self-report measures*

		Willingness to Change	Personal benefits	Collective benefits
BIF		.173	.267**	.000
Values				
	Biospheric	.378**	.393**	.219**
	Altruistic	.220*	.304**	.279**
	Hedonic	.117	−.050	−.187
	Egoistic	−.151	−.085	.054
Schultz values				
	Biospheric	.578**	.383*	.353**
	Altruistic	.433**	.323*	.320**
	Egoistic	.361**	.336**	.247**
Benefits				
	Personal	.269**	-	-
	Collective	.425**	−.016	-
Age		−.093	.033	−.075
Gender		.135	.046	−.076

Table A2.2 *Analyses for moderating effect of biospheric values and BIF (i.e., trait construal level) on willingness to change*

	Willingness to Change	
	(1)	(2)
Environment	1.52 (0.41)***	1.59 (0.41)***
Health	1.54 (0.48)**	1.62 (0.49)**
Environment × Health	−1.21 (0.64)*	−1.37 (0.64)*
Biospheric values	0.09 (0.20)	0.37 (0.08)***
BIF	1.12 (0.50)*	0.89 (1.09)
Biospheric × Environment	0.27 (0.22)	
Biospheric × Health	0.29 (0.25)	
Biospheric × Health × Environment	−0.09 (0.33)	
BIF × Environment		0.09 (1.38)
BIF × Health		0.80 (1.56)
BIF × Health × Environment		−0.40 (2.08)
Constant	2.88 (0.63)***	2.83 (0.63)***
Observations	126	126
R^2	0.322	0.305

Note. Env = environmental message, BIF = behavior identification form (measure of trait construal level)

Appendix 3. Messages Study 2

(Dutch version available upon request)

Enjoy this lovely shower gel!

Did you know that taking long and hot showers is actually quite damaging to the environment? By taking shorter and colder showers you do not only reduce your water use, but you also save the energy that is needed to heat up the water.

WAGENINGEN UR
For quality of life

Enjoy this lovely shower gel!

Did you know that taking long and hot showers is actually quite damaging to your skin? By taking shorter and colder showers you can prevent dry skin and other skin irritations.

WAGENINGEN UR
For quality of life

Enjoy this lovely shower gel!

Did you know that taking long and hot showers is actually quite damaging to the environment and to your skin? By taking shorter and colder showers you do not only reduce your water use, but you also save the energy that is needed to heat up the water and you can prevent dry skin and other skin irritations.

WAGENINGEN UR
For quality of life

Enjoy this lovely shower gel!

WAGENINGEN UR
For quality of life

Chapter 4

Which construal level combinations generate the most effective interventions? A field experiment on energy conservation

This chapter is based on Griffioen, A. M., Handgraaf, M. J. J., & Antonides, G. (*invited to resubmit*). Which construal level combinations generate the most effective interventions? A field experiment on energy conservation. *PLoS ONE.*

Abstract

Many campaigns targeting pro-environmental behavior combine multiple approaches without properly understanding how these different approaches interact. Here we study the effect of such combinations. We apply construal level theory to classify different intervention approaches, which can either be at a high construal level (abstract and distant) or at a low construal level (concrete and proximal). In a field experiment we recruited 197 students living in one-person apartments in an all-inclusive student housing facility. We objectively measured their individual electricity and warm water use, and measured psychological variables through surveys. We expected that the (commonly considered superior) combination between a high and a low construal level approach would be least effective. Participants were randomly assigned to a 2(Construal Level: low vs. high) × 2(Social Distance: low vs. high) plus control condition between-subjects design targeting a reduction in warm water use. Our findings suggest that a congruent combination at a high construal level (i.e., the high construal level condition combined with the high social distance condition) has the largest effect on warm water use and that spillover to electricity use is most likely to occur when a high construal level is used (i.e., high social distance). Moreover, especially participants who valued nature and the environment less were most strongly influenced by the combination of two high construal level approaches. In sum, our study suggests that when designing interventions one should consider the construal level and when targeting pro-environmental behavior high construal levels appear most appropriate.

Keywords: Construal level theory, energy conservation, spillover behavior, field experiment

4.1 Introduction

Environmental campaigns frequently appeal to several motivations at the same time in an attempt to achieve maximum impact on behavior. Policy makers, for example, use slogans such as "Save Money, Save Energy, Save the Environment" (Raven Housing Trust, 2013), which is expected to be effective based on the premise that some people value the environment, whereas others value the financial benefits of saving energy (van Dam & van Trijp, 2016). Although some studies support this premise (Bain et al., 2016; Dietz et al., 2009; Stern, 2000), Schwartz et al. (2015) showed the contrary; appealing to both financial and environmental benefits of an energy saving program at the same time was less effective than appealing to the environmental benefits alone. We argue that this may be due to the construal level (i.e., the level of abstraction) these appeals elicit among consumers. In this example, the monetary benefits of energy saving behavior are more concrete, personally relevant and will likely materialize in the near future, which is associated with a low construal level. In contrast, the environmental benefits of energy saving behavior are far more abstract, less personally relevant and the consequences are uncertain, which corresponds to a high construal level. We argue that two appeals that are at different construal levels are not very effective when targeting pro-environmental behavior. We, therefore, aim to test whether construal level is a possible explanation for the (in)effectiveness of particular combinations of interventions.

To date, it remains largely unclear how to combine different interventions in an effective manner (Abrahamse et al., 2005; Delmas et al., 2013). Notwithstanding the fact that some combinations do not work well together, combinations in general do have the potential of having a larger impact on behavior as compared to single approaches. The aim of our current research is to study the effects of combinations of interventions at different construal levels on pro-environmental behavior, and specifically on energy conservation behavior. Besides studying the effects on targeted behavior, we also investigate effects on other, related (spillover) behavior. By manipulating the construal level of two interventions we aim to understand whether combinations that are at the same level or at different levels of construal are more effective when targeting energy saving behavior. We specifically study the effects on curtailment (i.e., habitual energy use) behavior, and how changes in such day-to-day behavior affect overall energy use. We test the effectiveness of these combinations in a unique field setting where we can, besides self-report measures, objectively measure individual energy and water use over the course of our experiment.

4.1.1 Construal level theory

As people can only experience the here and now, construal level theory poses that one has to imagine events that are not taking place right here and now at some level of abstraction (Trope & Liberman, 2010). This indicates that people can think of an event at either a low level of abstraction, which means the event is construed in a very concrete manner, or at a high level, where the event is construed more abstractly. For example, when one decides to recycle a plastic bottle, at a low construal level one looks for the bin and throws it in, whereas at a high construal level one may think of the consequences of plastic garbage for the environment (Fujita et al., 2013). Construal level theory indicates that when people think at a low construal level they think more about the context-specific features of behavior and people are less able to separate important goals from other unimportant features (Liberman & Trope, 1998). Therefore, when people think at a low construal level, they are more susceptible to the influence of contextual factors that may either promote or inhibit pro-environmental behavior, and people are concerned with "how" they can perform certain behavior (Ledgerwood, Trope, & Chaiken, 2010; Trope & Liberman, 2010). At a high construal level thoughts tend to become more coherent and structured, and people often leave out irrelevant details (Trope & Liberman, 2003). In behavioral terms, a high construal level suggests that behavior is mostly guided by inner values and superordinate goals, and that people are concerned about "why" they engage in certain behavior (Eyal et al., 2009).

High and low construal level thinking are both used naturally by people when thinking about objects or behavior (Wakslak et al., 2007). Besides the fact that people can spontaneously shift between high and low levels of construal, different construal levels can also be experimentally manipulated by message framing or offering contexts that influence the construal level (Freitas et al., 2004). Moreover, construal level can be indirectly manipulated by varying one of the psychological distance dimensions, which include temporal, social, spatial and hypothetical distance (Liberman & Trope, 1998; Trope & Liberman, 2003). Construal level theory poses that the more psychologically distant an object, event or behavior is, the more abstractly it is perceived by people, thus implying a higher construal level. In terms of interventions with a focus on environmental benefits, this is associated with a large psychological distance on all four dimensions (Carmi & Kimhi, 2015; Griffioen et al., 2016), whereas personal benefits (e.g., financial) relate to smaller psychological distance on those dimensions (MacDonnell & White, 2015; Vohs, Mead, & Goode, 2006). For example, when environmental benefits of saving energy are highlighted, the exact

consequences of this behavior concern benefits to society at large (social) and the entire planet (spatial), will only materialize later in time (temporal), and, finally, will be quite uncertain (hypothetical). Even though environmental problems could be framed as being more psychologically proximal, one inherent feature of environmental problems is that people have the tendency to believe that the consequences are more likely to affect other people than themselves (Leiserowitz, 2005). Therefore, the social distance of environmental problems is often experienced as being large and appealing to other benefits that are closer in social distance may be the only way to decrease the distance on this dimension.

4.1.2 Combining construal levels: Congruent versus incongruent interventions

Interventions frequently combine multiple approaches, based on the somewhat simplistic reasoning that combinations have the potential of having a larger effect across more individuals. From a construal level theory perspective, there are two ways in which combinations could be formed: either the two (or more) interventions are at different construal levels (high and low), or the interventions are at the same construal level (high and high, or low and low).

Some studies have looked at the potential benefits of two manipulations that are at different construal levels. Most studies show that combining high and low construal level interventions are not very effective (Schwartz et al., 2015; White, MacDonnell, & Dahl, 2011), with the exception of one study that found that the combination of a high and low construal level increased participants' willingness to donate to charity (Rabinovich et al., 2009). Construal level theory provides a possible explanation for the ineffectiveness of combinations that are at different construal levels, based on the premise that people attend and process information differently depending on their construal level. According to construal level theory, when a high and a low construal level approach are combined, people may give more attention to the low construal level factor, since they can relate more easily to the concrete, low level component as it represents "[t]he pushes and pulls of everyday life" (p. 92; Fujita et al., 2013). This suggests that when high and low construal levels are combined, the effect of the high construal level approach is completely cancelled out by the low construal level component.

Here, we argue that people process information more efficiently when two intervention approaches are at the same level of construal. In line with this idea, in a series of lab studies, Amit, Algom, and Trope (2009) found that when there was fit between the presentation medium (words vs. pictures) and psychological distance, processing was more efficient in recall experiments and in a response time experiment.

In relation to pro-environmental behavior, previous studies found that a match in terms of construal level –either at a high or low level– was more effective in promoting pro-environmental intentions and behavior than a mismatch (Chang et al., 2015; White et al., 2011). Moreover, studies that aim to stimulate pro-environmental behavior seem to favor appeals to self-interest and pro-social motivations, either at the same time or separately. Goldsmith, Newman, and Dhar (2016) showed that congruent combinations were again most effective. Congruent combinations were operationalized as the combination between low construal level thinking and self-interest appeals, and between high construal level thinking and pro-social appeals. We extend this logic and argue that appeals to either self-interest or pro-social benefits of pro-environmental behavior differ on at least one of the psychological distance dimensions: social distance. Specifically, appeals to self-interest are small in social distance and appeals to pro-social motivations can be seen as large in social distance. This reasoning is in line with previous work, showing that self-interest appeals evoke low construal level thinking (Hunt et al., 2010). As such, we argue that the combinations were effective because they were aligned in terms of their (indirect) construal levels. Previous research thus supports the idea that a fit in construal level of different interventions plays an important role in how people attend to information and how this influences their decision making and behavior. Therefore, in this paper we argue that congruent construal level combinations will be more effective in changing behavior than incongruent combinations.

4.1.3 Congruent construal level manipulations: High versus low

If indeed construal level combinations that are at the same level are the most effective, the question remains whether low or high construal level combinations work best. Clearly, high and low level construals are processed differently, which implies that different factors drive the ultimate decisions and behavior. In terms of pro-environmental behavior, some researchers have argued in favor of high construal levels (Fujita et al., 2013), whereas other researchers have argued that environmental problems should be communicated as a present and personal risk and thus at a lower construal level (Gifford, 2011; van der Linden et al., 2015). Important to note is that people may arrive at the exact same decision via either the high or the low construal level path (Spence & Pidgeon, 2010). Therefore, it is possible that high and low construal level approaches are equally effective as long as combinations are congruent in terms of construal level.

In terms of decision making processes, at a low construal level people are mostly directed by the concrete, detail-specific features of events (Ledgerwood et al., 2010).

Moreover, low level of construal approaches have been associated with feasibility concerns (Fujita et al., 2008), suggesting that when a behavior is easy and feasible people will most likely engage in that behavior. However, when the situation does not facilitate the behavior, it is more likely that people will focus on the potential barriers or extra effort they have to exert and thus might not change their behavior.

For high construal level approaches, people focus more on the general goal the behavior is serving (Ledgerwood et al., 2010), which may be beneficial in the case of pro-environmental behavior. Goldsmith, Newman, and Dhar (2016) found that high construal level appeals are most effective when people were thinking in more abstract, high level terms when stimulating green product choice. Additionally, when people think at a high construal level they are usually guided by their inner values (Hunt et al., 2010). Making people act upon their inner values can be potentially beneficial when trying to stimulate pro-environmental behavior, as people often do not act upon their inner values in many everyday situations (Ledgerwood et al., 2010). However, as high construal levels make people act more upon their values, this may only be beneficial when people actually value the environment (Giacomantonio et al., 2010) and the high level of construal approach specifically highlights existing pro-environmental values. We expect that both high and low construal level approaches can be effective, but that behavior is guided by different motivations or considerations.

4.1.4 The role of biospheric values

When people think at a high construal level, pre-existing values seem to be an important determinant for their decisions and behavior (Eyal et al., 2009; Trope & Liberman, 2010). In terms of pro-environmental behavior, previous studies show that especially biospheric values have a strong positive relation with pro-environmental intentions and behavior (Corner et al., 2014; Steg et al., 2011). In contrast, egoistic values have negative associations with pro-environmental behavior (de Groot & Steg, 2010). Therefore, people who strongly endorse biospheric values generally display more pro-environmental behavior, and high construal levels are expected to appeal to these inner values which may in turn lead to even more pro-environmental behavior. Indeed, Brügger et al. (2015) show that when people think of climate change as a distant issue, they act more upon their (altruistic and) biospheric values. Likewise, Bolderdijk, Gorsira, Keizer, and Steg (2013) showed that only people who strongly endorsed the environment were affected by a movie about environmental consequences of bottled water in terms of their policy support and intentions.

At the same time, however, when people do not strongly value the environment, but instead endorse egoistic values, high construal level approaches may lead to more

egoistic behavior, as people act in line with these values (Giacomantonio et al., 2010). This is rather unfortunate, as people who score higher on egoistic values may already engage less in pro-environmental behavior, whereas they have the biggest potential in terms of behavior change. This is in contrast to people who highly value the environment and already engage in many pro-environmental activities, which suggests that there is little room for improving their current behavior. In line with this reasoning, Schoenefeld and McCauley (2015) found that people who scored higher on self-transcendent (i.e., altruistic and biospheric) values were not affected by information about climate change impacts, either at a high or low construal level. This indicates that people who value the environment may not be affected by manipulations targeting behavior change, for example, because they already act pro-environmentally. Although values are relatively stable traits that do not change in a short period of time (Spence, Leygue, Bedwell, & O'Malley, 2014), making particular values temporally salient can influence subsequent choices and behavior (Evans et al., 2013; Maio et al., 2009; Verplanken & Holland, 2002). Therefore, one way to motivate individuals who have weaker biospheric values is by strengthening their biospheric values, which may lead to more pro-environmental behavior than before (de Groot & Steg, 2008). When interventions strengthen biospheric values and are at a higher construal level this combination may thus be most effective in realizing behavior change.

4.1.5 Spillover behavior

Besides the direct effects of construal level on a target behavior, pro-environmental behavior is usually not just about making one choice, but about making many choices across many different contexts over longer periods of time. Truelove, Carrico, Weber, Raimi, and Vandenbergh (2014) call this the "net environmental impact," which transcends the effect on the target behavior, and also considers the longevity of these effects and the effects on related behaviors (spillover). Spillover occurs when an intervention also affects another behavior than the targeted behavior. Pro-environmental spillover is positive when it leads to additional pro-environmental behavior and negative when it leads to less pro-environmental behavior (Thøgersen & Crompton, 2009).

It has been suggested that high construal level thinking may lead to behavior change that is more lasting over time and less context specific (Fujita et al., 2013). Moreover, Mullen and Monin (2016) argue that when people think at a high construal level they focus on their values and superordinate goals, which leads to consistency across different behavioral domains, and thus to positive spillover. In contrast, low

construal level thinking induces a focus on concrete actions and consequences, which may lead to no spillover at all. In line with this, Evans et al. (2013) found that a combination of a high and low construal level (viz., appealing to environmental and financial benefits) did not lead to positive spillover, whereas only appealing to a high level of construal (viz., the environmental benefits of pro-environmental behavior) did lead to positive spillover. Therefore, we argue that high construal level combinations are the most effective in terms of spillover behavior and net environmental impact in general.

4.2 Current research

Based on the assumption that combined intervention approaches can be more effective in stimulating pro-environmental behavior than single interventions, this research aims to investigate which combinations of high and low construal level interventions are most effective. We will measure effectiveness of combined construal level manipulations on a target behavior, warm water use, as well as on related behaviors, such as electricity use. We have chosen warm water use, as it is the second most impactful behavior in terms of energy consumption in the household (after space heating/cooling) and accounts for approximately 18% of household energy use (Tiefenbeck, Staake, Roth, & Sachs, 2013). Moreover, in our experiment warm water use was much more explicitly under control of our participants as compared to space heating/cooling, which is mostly automatic. In our experiment participants received two manipulations that were intended to affect their construal level (see Method section). The first manipulation was a commonly used direct construal level manipulation (i.e., "how versus why" task; Freitas et al., 2004) and the second manipulation was an indirect construal level manipulation, by manipulating social distance. We chose to manipulate social distance for two main reasons: environmental problems are usually perceived as being socially distant and previous work often contrasts personal with non-personal benefits (i.e., values; Goldsmith et al., 2016; Schwartz et al., 2015). To be able to test the effectiveness of high and low construal level approaches as clean as possible, we wanted to test this in a situation in which personal (low construal level) benefits of energy conservation behavior are naturally lacking. Therefore, we studied this in a field experiment, in which participants did not pay for the energy they used. In this particular situation, we expect that combinations that are at the same level of construal (i.e., that have construal level fit) have a greater impact on the target behavior (warm water use) as compared to combinations that are at different levels of construal. This leads to *Hypothesis 1*:

Combinations at the same construal level will have a greater effect on warm water use reduction as compared to non-aligned combinations.

Moreover, in terms of expected spillover, we expect that the combination of two high construal level approaches will have the largest impact on related behaviors (e.g., electricity use), as compared to the other combinations. This leads to *Hypothesis 2: The congruent high construal level combination will have a greater effect on spillover behavior compared to the other construal level combinations.*

Finally, values play an important role in terms of construal level and pro-environmental behavior. Based on previous research, we expect that biospheric values can influence behavior in one of two ways, which leads to two competing hypotheses. First of all, it could be that people who score high on biospheric values act more in line with these values when they are in the high construal level conditions, as compared to people who score lower on biospheric values (Eyal et al., 2009). Secondly, as people who score high on biospheric values are also expected to already engage in more pro-environmental behavior, it could be that people who actually score lower on biospheric values are affected to a larger extent by high construal levels than people who score high on biospheric values.

4.3 Methods

To test the effectiveness of the construal level combinations we ran an experimental field study. We focused on reducing warm water use at a student housing facility in the Netherlands. In this experiment, we manipulated construal level in two ways; with a direct construal level manipulation, by using an adjusted version of the "how versus why" task by Freitas et al. (2004), and an indirect construal level manipulation, by influencing social distance, providing participants either with a gift to self (low social distance) or gift to other (a donation to a charitable organization; high social distance). This study has been approved by the Research/Assessment Committee from the Wageningen School of Social Sciences, Wageningen University. All participants provided written informed consent at the beginning of the study.

Setting. In collaboration with an all-inclusive student housing facility, we installed detailed measurement equipment in 156 one-person apartments. This student housing facility provides high-end hotel-like rooms with private bathrooms. The installed equipment measures electricity use, warm water use, and presence in the room per participant on a minute-to-minute basis. This unique "living lab" setting, allows us to run experiments and collect and analyze objective behavioral data. Moreover, as each apartment is occupied by one person, we are able to directly link

self-reported personal characteristics to the electricity and water use behavior in these rooms.

Participants and design. Participants were randomly assigned to a 2 (Construal Level: low vs. high) × 2 (Social Distance: low vs. high) plus control condition in a between-subjects design. Participants were asked to fill out two surveys; one survey before the intervention as a baseline measurement, and one survey four weeks after the intervention. Participants (n = 197, M_{age} = 21.18, SD_{age} = 3.76, 53.3% female) were recruited in two waves. In the first wave of data collection in April 2015, 91 students (M_{age} = 22.13, SD_{age} = 3.98, 50.5% female) participated of whom 89% filled out both surveys, and in the second wave in September 2015, 106 students (M_{age} = 20.36, SD_{age} = 3.38, 56.6% female) participated of whom 88.7% filled out both surveys. No students participated in both waves.

Procedure. Students, staying in rooms with measurement devices on water use, energy use and presence, received an email with a link to the online survey. As the initial response rate was rather low, a member from the research team approached students in person at the hotel and asked them to fill out the online survey.

Upon opening the online survey, participants were asked to agree to the informed consent form. Additional to a regular informed consent form, students were explicitly informed that the answers to this survey would be linked to their individual energy and water usage and were asked if they agreed with this procedure. Thereafter, participants filled in a number of questions (see Measures). After answering these questions, participants were presented with the first construal level manipulation, the "how versus why" task. Participants were then asked to indicate the ease of processing of the task and their level of self-efficacy. Students were asked to read the explanation of the initiative (see Appendix 3) and finally were asked for their demographic information. After completing the first survey, participants were contacted by one of the researchers for the social distance manipulation. Participants were given the option to choose a gift (depending on the condition they were in), which they received in Week 3 of the experiment. Therefore, due to the design of the study, all participants had received both manipulations in full by the end of Week 3, which makes Week 4 the week of interest in terms of the effects of the combined construal level interventions on water and electricity use. Finally, participants were asked to fill out a post-intervention survey in week 4, which was sent to them via email.

Manipulations.

Construal level. Participants were asked to fill out an adjusted version of the "how versus why" task (Freitas et al., 2004), which has been designed to only vary the level of abstraction at which people think about the same activity. In the low construal level

condition participants were asked to list three means to reduce their water use to preserve the environment and to rate these in reference to the question "How much will engaging in this activity reduce your water use at The Student Hotel?" on a 5-point scale (1 = *a little,* 5 = *very, very much*). In the high construal level condition participants were asked to list three ways in which reducing their water use to preserve the environment could help reach important life goals. Participants were also asked to rate, in reference to each goal that they had listed, "How much will reducing your water use at The Student Hotel help you reach this goal?" on a 5-point scale (1 = *a little*, 5 = *very, very much*). Finally, participants were asked to complete a diagram, which asked them to indicate how (in the low construal level condition) or why (in the high construal level condition) they should reduce their water use (see Appendix 1). This way, participants in the high construal level condition were asked to think more and more abstractly about reducing their water use, whereas participants in the low construal level condition were asked to think increasingly concretely about reducing their water use (Freitas et al., 2004).

Social distance. In order to increase participation in the experiment participants received a gift, which was non-contingent, which means that all participants received the gift irrespective of their behavior. Participants in the low social distance condition were given the option to choose a gift from four options (low social distance), and participants in the high social distance condition were given the option to choose one of four charities they wished to support (high social distance). The various gift options can be found in Appendix 2.

Participants received the gift three weeks after completing the survey, which means that in week 4 after completing the survey, all participants had received both manipulations (i.e., the construal level and the social distance manipulation). Participants in the high social distance condition received a certificate stating their name and the charitable organization they indicated to donate to at the same time as the participants in the low social distance condition received their gift. Upon receiving the gift, participants also received a message which provided a short recap of the construal level task they had received when completing the pre-intervention survey (see Appendix 3).

Measures. Unless otherwise indicated, participants scored all survey items on a 7-point Likert-type scale (1 = *strongly disagree,* 7 = *strongly agree*). Information on all measured constructs in both the pre-intervention and post-intervention survey is depicted in Table 1.

Trait construal level. Participants were asked to fill out 10 items from the Behavior Identification Form (BIF; Vallacher & Wegner, 1989), a standard scale, to measure

their trait construal level. Items were selected based on relevance to students in the Netherlands, and on the correlations with the other items. Participants were asked to select one description of behavior that appeared most appropriate to them. For example, for "Painting a room" participants could choose between "Applying brush strokes" (low level, scored as 0) and "Making the room look fresh" (high level, scored as 1). The scores were summed, and higher scores thus indicated higher levels of construal.

Perceived sustainability. Participants rated the perceived sustainability of the student housing facility on three items (e.g., "The Student Hotel is a sustainable residence").

Environmental self-identity. Environmental self-identity was assessed with the scale developed by van der Werff, Steg, and Keizer (2013) consisting of three items (e.g., "Acting environmentally friendly is an important part of who I am").

Values. To assess personal values, participants rated items from Schwartz's value scale (1992) as "*guiding principles in their life*" on a 9-point perceived importance scale (−1 = *opposed to my principles*, 0 = *not important*, 7 = *extremely important*). We included three items for hedonic values (e.g., "Pleasure: gratification of desires"), five items for egoistic values (e.g., "Social power: control over others, dominance"), four items for altruistic values (e.g., "Equality: equal opportunity for all") and four items for biospheric values (e.g., "Respecting the earth: harmony with other species"; de Groot & Steg, 2008).

Ease of processing. To assess the ease of processing of the construal level task and information provided in that task, participants were asked to score whether the thought experiment was: "difficult to process/easy to process," "difficult to understand/easy to understand," or "difficult to comprehend/easy to comprehend" (Lee & Aaker, 2004).

Self-efficacy. To assess perceived efficacy in terms of reducing energy and water use at home, participants were asked to score three items (e.g., "I feel that I know how to go about reducing my energy and water use"; White et al., 2011).

Demographics. Finally, we asked participants for their demographic information, including age, gender, nationality, and level of education. We also asked participants' room numbers, with which they could access the second survey and which we used to link the measured water and electricity data to their survey answers.

Table 1 *Descriptive Statistics of Measures from Pre-Intervention and Post-Intervention Survey*

		Pre-intervention survey				Post-intervention survey			
Variable	Items	*n*	M	*SD*	*Rel.*	*n*	M	*SD*	*Rel.*
Trait construal level	10	197	5.90	2.19	.596	172	6.37	2.22	.642
TSH Sustainability	3	197	4.76	1.11	.766	171	4.96	1.08	.812
Env. self-identity	3	197	5.09	1.01	.901	171	4.99	1.12	.953
Values									
Hedonic	3	197	5.24	1.41	.863	166	5.18	1.38	.869
Egoistic	5	197	3.84	1.43	.804	166	3.95	1.38	.828
Altruistic	4	197	5.43	1.37	.885	166	5.46	1.33	.879
Biospheric	4	197	5.15	1.51	.934	166	5.24	1.43	.926
Efficacy	3	197	5.17	0.94	.683	167	5.08	1.01	.819
Water behavior									
Shower	4	197	3.34	1.29	.711	170	3.67	1.32	.757
Average shower time	2	197	10.95	5.50	.892	171	11.00	7.08	.921
Electricity behavior									
Switching off	2	197	4.36	1.67	.702	170	4.57	1.58	.749
Appliance use	4	197	5.31	1.06	.669	170	5.36	0.99	.694
Pro-env. behavior									
Recycling	3	197	3.40	1.06	.727	170	3.45	1.00	.769
Buying env.-friendly products	2	197	2.80	0.90	.618	170	2.83	0.98	.721
Eating meat	1	197	3.55	1.24	-	170	3.48	1.21	-

Note. Rel. = Reliability; Reliability shows Cronbach's alpha for multi-item scales and the Spearman-Brown coefficient for two-item scales.

Post-intervention survey. The post-intervention survey was mostly identical to the first survey, except that it excluded the construal level task and the demographic questions. Additionally, in the post-intervention survey we asked participants how much they liked their gift (1 = *not happy*, 5 = *very happy*; M = 4.17, *SD* = 1.00) and how much they would be willing to pay for their gift in Euros (M = 7.40, *SD* = 5.57, *n* = 126).

Figure 1 depicts the design of the study and shows which steps were taken for each week specifically. As participants received the full manipulation (by the time they had received the gift) in week 3, week 4 is the main week of interest in the following analyses.

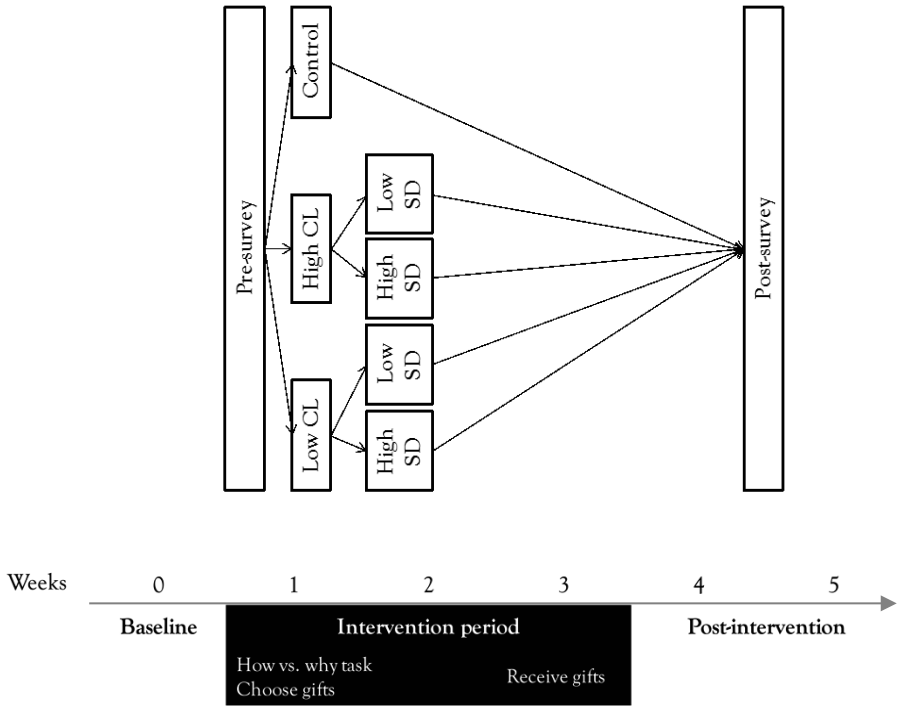


Figure 1 Design of experiment. CL = construal level, SD = social distance.

Objective measurements of energy use. Throughout the intervention period objective measurement equipment recorded individual water use, electricity use, and presence (measured with the card readers in their room). More specifically, we obtained data on a 10-minute basis for hot water use and electricity use. Electricity use was measured at two levels: the lighting and the sockets. Finally, the card reader was used as a measure of the participant's presence in the room. For all objective measurements we use the percentage difference in energy use (i.e., water and electricity use) as compared to the control group as our dependent variable. A detailed description of the exact use of the objective data in the subsequent analyses can be found in Appendix 4.

4.4 Results

To measure the effects of the manipulations on the dependent variables (energy or water use data), we ran a series of repeated measures analyses of variance with our within subjects variables measured at least two points in time and the manipulations of construal level and social distance as the independent between-subjects variables.

In all analyses we always controlled for a number of variables: the time of data collection (wave 1 or wave 2), trait construal level (measured by the Behavior Identification Form), biospheric values, age, and gender. In the following section the effects on the objective measurements of water and electricity use data will be reported. In the Appendices, the correlations between the self-report variables and objective measurements of water and electricity use are reported (Appendix 9), as well as the effects of the manipulations on self-report behavior (Appendix 5) and supporting analyses on the objective energy use data (Appendices 6-8).

4.4.1 Target behavior

Six-week trend water use. To test whether the experimental conditions had an (interaction) effect on the water use throughout the entire intervention period, we performed a repeated-measures analysis with six levels. Each level represents the average water use for each of the six consecutive weeks, where the first level represents the baseline week, which is the week before participants filled out the pre-intervention survey (week 0), and the subsequent weeks represent each week after filling out the survey. Participants only received the gift (i.e., to self or other) in week 3, making week 4 our main interest. However, we were also interested whether we could already observe changes before participants had actually received their gift and therefore we first analyzed the pattern of water use throughout the entire intervention period. First of all, time had a significant effect on water use throughout the six-week period, $F(5,740) = 2.44$, $p = .033$, $\eta_p^2 = .016$. This effect indicated that, compared to the control group, participants in the experimental conditions reduced their warm water use over the course of the experiment. Besides the main effect of time, time did not significantly interact with social distance ($F(5,740) = 0.29$, $p = .919$, $\eta_p^2 = .002$), construal level ($F(5,740) = 0.47$, $p = .800$, $\eta_p^2 = .003$), or the interaction between construal level and social distance ($F(5,740) = 1.15$, $p = .332$, $\eta_p^2 = .008$).

Figure 2 depicts the average water use throughout the period from one week prior to the intervention to five weeks following the intervention. In addition to this analysis, we also analyzed the data per week separately and an additional graph showing the absolute water use throughout the six-week for all conditions, including the control condition (shown in Appendices 10 and 11, respectively).

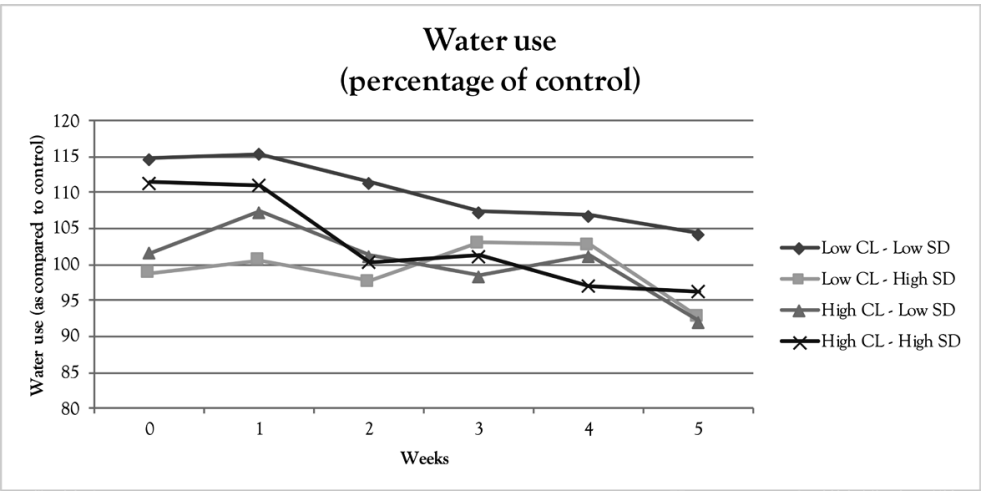


Figure 2 Water use depicted as percentage of control group during the six-week intervention period. CL = construal level, SD = social distance.

Baseline vs. week 4 water use. As participants received the gift in week 3 of the experiment, our main focus was on the effect of the manipulations in the fourth week after participants had filled out the first survey. Employing a repeated measures analysis with two levels (1 week prior to filling in the survey and 4 weeks after filling in the survey), we found that time did not have a significant effect on the difference in water use ($F(1,150) = 0.60$, $p = .440$, $\eta_p^2 = .004$), nor was there a significant interaction between time and social distance ($F(1,150) = 0.05$, $p = .829$, $\eta_p^2 = .000$), or time and construal level ($F(1,150) = 0.84$, $p = .361$, $\eta_p^2 = .006$). However, we did find a marginally significant three-way interaction effect between time, social distance and construal level ($F(1,150) = 3.76$, $p = .054$, $\eta_p^2 = .024$). Figure 3 depicts the interaction between construal level and social distance in percentage change compared to the control group. A difference score was computed by subtracting the water use in week 0 (the week before the intervention) from water use in week 4 (after the intervention). This difference score was used to detect whether the change in water use was significantly different between the conditions. We used contrast analysis (i.e., LSD) to detect differences between the different combinations of manipulations. First of all, in the high social distance condition (gift to other), participants who were in the high construal level condition reduced their water use significantly more than participants in the low construal level condition ($M_{difference} = 18.28$, $F(1,150) = 3.91$, $p = .050$, $\eta_p^2 = .025$). Secondly, in the low social distance condition (gift to self), we did not find a significant difference between the high and low construal level condition ($M_{difference} = 6.66$, $F(1,150) = 0.57$, $p = .451$, $\eta_p^2 = .004$). Thirdly, the social distance manipulation

did not lead to significant differences in water use among participants in the high construal level condition ($M_{difference}$ = 13.85, $F(1,150)$ = 2.33, p = .129, η_p^2 = .015), nor among participants who were in the low construal level condition ($M_{difference}$ = 11.09, p = .220, η_p^2 = .010).

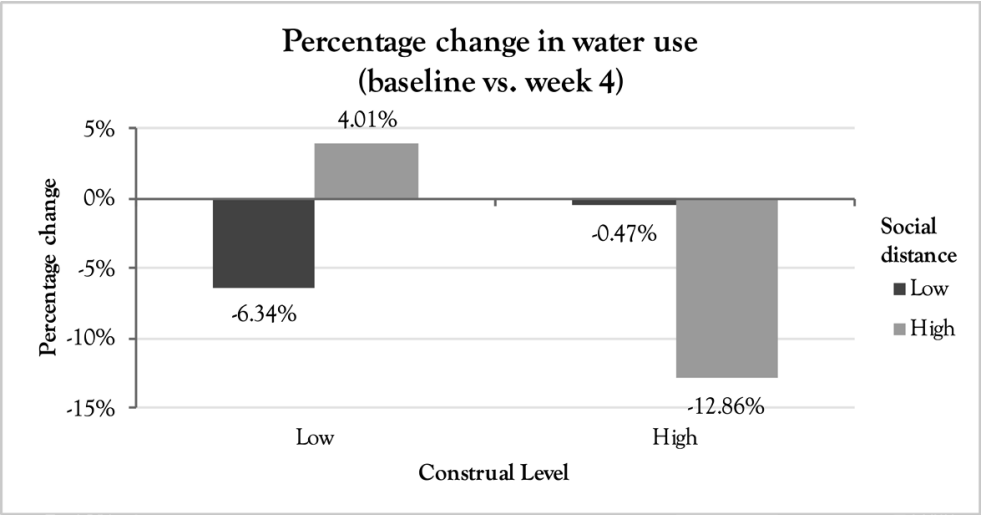


Figure 3 Percentage change in water use relative to control group between baseline (week 0) and week 4.

Besides the direct contrasts between the specific conditions, we also contrasted the congruent combinations (i.e., the high-high and low-low combinations) to the incongruent combinations (i.e., low-high combinations), and found a marginally significant difference ($M_{difference}$ = 12.17, $SE_{difference}$ = 6.40) between these two groups of conditions (p = .059). In other words, participants in the congruent construal level combinations reduced their water use more than participants in the incongruent combinations. Additionally, we found that participants in the congruent high construal level combination reduced their water use more than all other combinations ($M_{difference}$ = 12.75, $SE_{difference}$ = 7.42), which was marginally significant (p = .088). Additionally, comparing the two congruent combinations with one another, we found that there were no significant differences between the two congruent combinations ($M_{difference}$ = 6.99, $SE_{difference}$ = 8.63, p = .419). Finally, we analyzed whether the change in water use was significantly different from a 0% change. As such, only participants in the congruent high construal level combination condition (i.e., high social distance and high construal level) showed a significant reduction in their water use as compared to no change ($t(150)$ = 2.25, p = .026, η_p^2 = .033). The other combinations

did not significantly differ from a 0% change (low social distance and low construal level ($t(150) = -1.20$, $p = .233$, $\eta_p^2 = .009$); low social distance and high construal level ($t(150) = -0.10$, $p = .918$, $\eta_p^2 = .000$); high social distance and low construal level ($t(150) = 0.58$, $p = .565$, $\eta_p^2 = .002$)). These results provide only partial support for Hypothesis 1 and show that the congruent high construal level combination is effective, especially compared to incongruent combinations, but is not significantly more effective than the congruent low construal level combination.

4.4.2 Biospheric values as a moderator

Biospheric values have been pinpointed as a predictor of pro-environmental behavior. To test our two competing hypotheses, we explored the potential moderating effect of biospheric values and added biospheric values to the repeated measures analysis.

Baseline vs. week 4 water use. The repeated measures analysis with two levels (1 week prior to filling in the survey and 4 weeks after filling in the survey) indicated that time did not have a significant effect on water use ($F(1,147) = 1.00$, $p = .319$, $\eta_p^2 = .007$) nor did time interact with social distance ($F(1,147) = 2.14$, $p = .145$, $\eta_p^2 = .014$), construal level ($F(1,147) = 0.75$, $p = .387$, $\eta_p^2 = .005$), social distance and biospheric values ($F(1,147) = 2.16$, $p = .144$, $\eta_p^2 = .014$), or construal level and biospheric values ($F(1,147) = 0.48$, $p = .492$, $\eta_p^2 = .003$).

The analysis did reveal a significant three-way interaction between time, social distance and construal level ($F(1,147) = 6.10$, $p = .015$, $\eta_p^2 = .040$) and a four-way interaction between time, social distance, construal level and biospheric values ($F(1,147) = 4.37$, $p = .038$, $\eta_p^2 = .029$). This interaction showed that biospheric values affected the effectiveness of the construal level manipulation in combination with the social distance manipulation. Using the PROCESS macro by Hayes (2013), we further analyzed the three-way interaction between the experimental conditions and biospheric values on water use. People who scored high on biospheric values (mean +1 SD) were not affected by the combination of manipulations, as the interaction between time, social distance and construal level was not significant ($F(1,147) = 0.00$, $p = .970$, $\eta_p^2 = .000$). In contrast, participants who scored lower on biospheric values (mean −1 SD) were influenced by the combination of manipulations, as the interaction between time, social distance and construal level remained significant ($F(1,147) = 7.85$, $p = .006$, $\eta_p^2 = .051$). For people who scored lower on biospheric values, we found the following effects of the interaction between the construal level manipulation and the social distance manipulation. First of all, the construal level manipulation had a significant effect on water use among participants in the high

social distance condition ($t(147) = -2.82$, $p = .005$). More specifically, participants who were in the high construal level condition reduced their water use significantly more than participants in the low construal level condition (see Figure 4). Secondly, the construal level manipulation did not have a significant effect among participants in the low social distance condition ($t(147) = 1.26$, $p = .211$). Thirdly, social distance had a significant effect on reduction in water use among participants who were in the high construal level condition ($t(147) = 2.85$, $p = .005$). Particularly, participants in the high social distance condition reduced their water use significantly more than participants in the low social distance condition. Finally, social distance did not have a significant effect on the reduction in water use among participants who were in the low construal level condition ($t(147) = -1.22$, $p = .225$). The interaction between biospheric values and the experimental conditions is depicted in Figure 4, showing the percentage change from baseline to week 4.

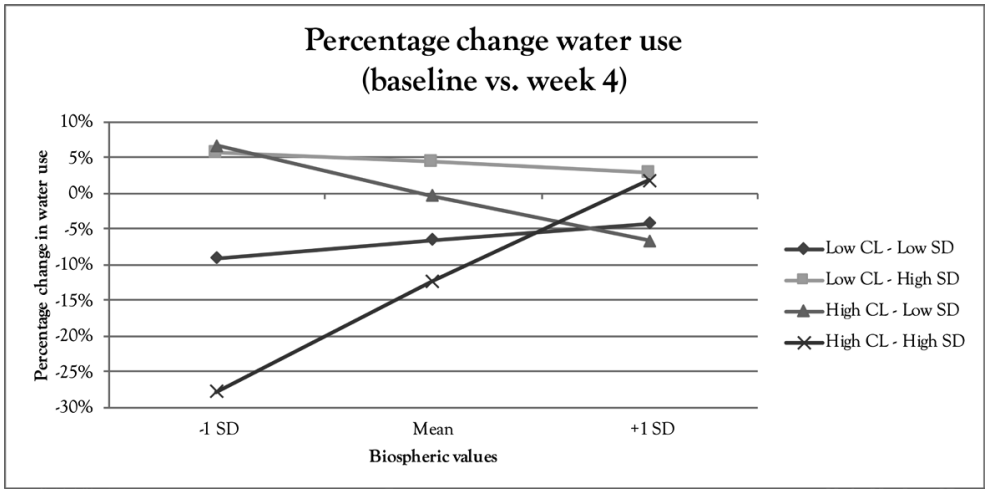


Figure 4 Percentage change in water use between baseline (week 0) and week 4 with biospheric values as moderator. SD = social distance, CL = construal level.

Besides the moderating effect of biospheric values, construal level theory poses that people are more inclined to act upon their values when they think at a high construal level. Next to the moderation analysis on change in water use, we were interested in the correlation between biospheric values (measured on the pre-intervention survey) and absolute water use. We therefore specifically tested whether the correlation between biospheric values (measured on the pre-intervention survey) and water use was stronger among participants in the congruent high construal level combination. Across all participants, baseline water use did not correlate with

biospheric values (Pearson's r =−.011, p = .884), nor did biospheric values correlate with water use in week 4 (Pearson's r = .093, p = .205). However, when we looked at the specific correlations between water use and biospheric values for the high congruent construal level combination, we found that although biospheric values did not significantly correlate with baseline water use (Pearson's r = .044, p = .783), biospheric values did significantly correlate with water use in week 4 (Pearson's r = .421, p = .008). Across all other combinations, biospheric values did not significantly correlate with water use either at baseline or in week 4 ($p > .05$). This correlation thus indicates that people act more upon their values when they think at a high construal level.

4.4.3 Spillover behavior

Baseline vs. week 4 electricity use. To test the effect of the experimental conditions on electricity use, we also looked at the difference in electricity use between the week before filling out the survey and week 4 after filling out the survey.

Sockets. The repeated measures analysis of variance showed that time did not have a significant effect on socket use ($F(1,130) = 1.22$, p = .272, η_p^2 = .009). Moreover, we did not find a significant interaction with time on socket use for construal level ($F(1,130) = 0.01$, p = .931, η_p^2 = .000), or for the interaction with construal level and social distance ($F(1,130) = 0.20$, p = .655, η_p^2 = .002). Social distance did significantly interact with time ($F(1,130) = 5.84$, p = .017, η_p^2 = .043), which showed that participants in the low social distance condition increased their socket use (M_{pre} = 117.09, SE_{pre} = 7.66; M_{post} = 118.75, SE_{post} = 7.39), whereas participants in the high social distance condition reduced their socket use (M_{pre} = 118.93, SE_{pre} = 9.08; M_{post} = 95.38, SE_{post} = 8.76). Similar to water use, we also compared the congruent high construal level combination with the other combinations. We found a marginally significant difference, showing that those in the congruent high construal level combination condition reduced their socket use more than the other combinations ($M_{difference}$ = 22.57, $SE_{difference}$ = 12.43, p = .072).

Light. The analysis revealed no significant interactions between time and construal level ($F(1,130) = 2.15$, p = .145, η_p^2 = .016), nor between time, social distance and construal level ($F(1,130) = 0.26$, p = .612, η_p^2 = .002). In contrast to socket use, time did have a significant effect on light use ($F(1,130) = 7.19$, p = .008, η_p^2 = .052), which showed that participants across all experimental conditions decreased light use from baseline (week 0; M = 126.78, SE = 6.34) to week 4 after the intervention (M = 115.25, SE = 5.57). We also found a significant interaction between time and social distance

($F(1,130) = 3.90$, $p = .050$, $\eta_p^2 = .029$), showing that participants in the high social distance condition decreased their light use ($M_{pre} = 131.25$, $SE_{pre} = 9.85$; $M_{post} = 110.79$, $SE_{post} = 8.61$) significantly more than participants in the low social distance condition ($M_{pre} = 122.31$, $SE_{pre} = 8.31$; $M_{post} = 119.70$, $SE_{post} = 7.26$). In contrast to water and socket use, when we contrasted the congruent high construal level combination to the other combinations, we found no significant difference in terms of change in light use ($M_{difference} = 7.39$, $SE_{difference} = 10.89$, $p = .499$).

4.5 Discussion

This study was designed to investigate the effects of a combination of construal level manipulations on warm water use. Moreover, we looked at the possible moderating effect of biospheric values on water use and we were interested in the net environmental impact, which is why we also tested the effect of the two construal level manipulations on spillover to electricity use.

4.5.1 Congruent construal level combinations

Target behavior. Our main variable of interest in this study was the warm water use of participants. First off, we expected that participants who received a combination of manipulations that were at the same level of construal –either both at a high construal level or both at a low construal level– would be more effective than combinations of manipulations that were not aligned in terms of construal level (Hypothesis 1). Our results on the measured warm water use after the intervention (i.e., week 4) are partially in line with this expectation. Specifically, we found that a combination of two high-level construals was most effective in terms of motivating people to reduce their warm water use. Less effective, however, was the combination of two low-level construals. Moreover, participants who received a combination of a high and low construal level did not significantly change their water use. These results add to previous findings on construal level manipulations by showing that especially aligned high construal levels are effective when targeting warm water use. Due to the nature of the experiment, we could not specifically test how efficiently participants processed the combination of interventions. We speculate that the congruent combinations are processed more fluently (Amit et al., 2009). Moreover, when the two manipulations were at the same construal level, we believe that the manipulations enforce one another, whereas behavior in the incongruent combinations are solely driven by the low construal level component.

The high construal level combination was most effective in our experiment, while the low construal level combination did not lead to a significant reduction in warm

water use. One explanation for the ineffectiveness of the low construal level combination could be the fact that we targeted curtailment behavior, which we measured during multiple weeks. It could be argued that both aligned combinations are processed more efficiently, but that the low construal level combination was not effective in this longer-term situation. It could be that the low construal level combination is effective when one-off decisions are being targeted, as has been found in previous studies (Amit et al., 2009; Goldsmith et al., 2016; White et al., 2011). The fact that the combination of two high construal levels was most effective in this experiment may have been due to the type of behavior that was being targeted. While it has been suggested that high construal levels are more effective than low construal levels when targeting pro-environmental behavior (Fujita et al., 2013), this premise has not been extensively tested in either the lab or the field in direct reference to pro-environmental behavior. Our study provides initial evidence for the fact that high construal level approaches can indeed be more effective when targeting pro-environmental curtailment behavior. In sum, our findings suggest that a high construal level approach is only effective when combined with another high construal level approach and not when combined with a low construal level approach. In the latter case, the low construal level component may become the driving factor for behavior, which may not be very effective when targeting pro-environmental behavior.

In terms of the ineffectiveness of incongruent approaches, we believe that the low construal level component makes people consider the more immediate consequences of their behavior and evaluate the high construal level component in this light. As such, in the incongruent combination, participants in the low construal level condition (i.e., those exposed to the "how" task) were given the opportunity to choose to donate to a charitable organization. It could be that participants justified their lack of behavior change on the basis of their "good" deed of donating and, indeed, participants in this combination valued their gift the most. In the other incongruent combination, participants were asked to think about their water use at a high construal level and were subsequently given a gift to self. The latter manipulation made participants solely focus on their concrete, day-to-day considerations, rather than the overall impact of their behavior at a higher construal level. The way participants were asked to think about their water use was not in line with the type of gift they received and therefore was not effective in changing their behavior.

Biospheric values. We expected that biospheric values would moderate the effects of our manipulations in one of two ways. On the one hand, we anticipated that people with high biospheric values would be more affected by our high construal level manipulations, as they would act more upon their inner values. On the other hand,

we also theorized that people with high biospheric values could be less affected by our manipulations in general, as there is less room for improvement in their current behavior. Our results indicate that participants who scored lower on biospheric values were actually mostly influenced by the aligned high construal level manipulations. This is in contrast with construal level theory, which suggests that people act more upon their inner values when they think at a high rather than low construal level. Important to note, however, is that participants who scored lower on biospheric values still scored above the midpoint of the scale, indicating that they do care for the environment to some extent. Participants who scored highest on biospheric values hardly changed their water use, which could be due to a "ceiling effect." As such, previous studies (van der Werff et al., 2013) show that people who score higher on biospheric values also portray more pro-environmental behavior and, therefore, they may have reached a limit in how much they can still change. The fact that we did not find a significant correlation between biospheric values and objectively measured water use, but did find a significant correlation between biospheric values and self-reported energy use behavior, is interesting and important in itself. As most previous studies have found a significant correlation between biospheric values and self-reports, a lack of correlation with objective data is potentially problematic for predicting actual behavior on the basis of biospheric values. It therefore seems, as Klöckner (2013) argues as well, that other moderating and mediating factors influence the link between biospheric values and energy use behavior, especially when the latter is measured objectively. Note however, that we did find that participants in the congruent high construal level combination acted more upon their values in terms of their water use in week 4 (as shown by the significant correlation). This finding is in line with construal level theory, which poses that people act more upon their values when thinking at a high construal level. We consider the relationship between biospheric values and both objectively and self-reported energy use an important one that would be interesting to study in the future, for example, by running a meta-analysis.

Another explanation for the effectiveness of the high construal level combination, could be the goal that was highlighted in the direct construal level manipulation. As such, the direct construal level manipulation included an environmental goal in both the high and low construal level condition. When people think of this at a high construal level, they may act more upon these values, whereas at a low construal level values are not the driving factor of their behavior. As suggested, values can be made temporarily salient (Verplanken & Holland, 2002), which may have been the case when two high construal level approaches were combined. In other words, environmental values may have been made salient and people may thus have acted

upon these emphasized values. As noted, participants who scored lower on biospheric values still scored above the midpoint of the scale, indicating that they do care for the environment to some extent. Whether the same results hold for participants who indicate not to value the environment at all remains to be studied. Future research should look more into the role of values in direct reference to the effectiveness of interventions and other programs targeted at motivating people to act in a pro-environmental manner, especially among those who do not strongly endorse biospheric values or already act in a pro-environmental manner.

Spillover. In terms of spillover behavior, we expected that only the combination of two high-level construals would lead to positive spillover behavior (Hypothesis 2). Our results, however, indicate that the social distance manipulation by itself, irrespective of the construal level manipulation, had a significant effect on spillover to electricity use. More specifically, participants in the high social distance condition reduced their electricity use in terms of socket and light use more than participants in the low social distance condition. This is in line with earlier work by Evans et al. (2013) showing that appealing to self-transcendent values can lead to positive spillover. They argue that spillover occurs because important values are appealed to and this ultimately drives behavior. In terms of construal level theory, this argument would provide a similar explanation; appealing to self-transcendent values may lead to more abstract thinking and makes people see the similarities between different types of behaviors. Moreover, as people usually want to be consistent in their behavior (Festinger, 1954), they may, therefore, also be motivated to change their behavior in other areas. The fact that the direct construal level manipulation did not affect electricity use should be investigated in future work, in order to gain understanding in how different types of construal level manipulations affect spillover behavior.

4.5.2 Implications

This research provides an explanation for which combinations of interventions may work especially well when targeting pro-environmental behavior. As previous studies have shown mixed results on a multitude of combinations of intervention approaches, we wanted to take a closer look at the potential underlying factors that may determine the effectiveness of combined manipulation approaches. Especially for the target behavior, construal level theory provides a possible explanation for when some combinations do and do not work well together. Practically this explanation suggests that when, for example, designing intervention programs the construal level of the different types of manipulations should be considered. More specifically, our findings suggest that congruent high construal level combinations are most effective

when targeting pro-environmental curtailment behavior, and more specifically (warm) water use. In contrast, combinations that combine a high and low construal level were not effective, which suggests that these combinations should be avoided when designing campaigns targeting pro-environmental behavior. Moreover, spillover was also most likely to occur among participants in the high social distance condition, which is associated with a high construal level. Findings from our study, therefore, suggest that high construal level interventions should be favored over lower construal level interventions, as the high construal level manipulations have a greater effect on the target behavior as well as on other pro-environmental behavior. Moreover, the effects of these high construal level interventions were especially present for participants with lower biospheric values, which means that this is also a valid approach to motivate people who may not already act in a pro-environmental manner.

4.5.3 Limitations and future research

The unique living lab design of our study allowed for many analyses that are otherwise impossible to do. In particular, we could specifically target individual behavior, look at individual differences in direct reference to actual individual energy use and control for whether people were present or absent. This way, we could also see that objective and self-report measures are correlated to some extent (see Appendix 4), but that there is a gap. This is in line with previous research (Kormos & Gifford, 2014), which can be caused by different factors. For example, people may not be very capable of indicating how much water and energy they use at home, as it is a vague and abstract concept to them (Attari, 2014; Attari et al., 2010). As large proportions of studies in this field rely solely on self-reports, future research should study whether interventions result in similar patterns when using objective behavioral measures.

Despite the advantages of our design, there are some downsides to the design of this study as well. First of all, we ran our study with a student population, who mostly live by themselves for the first time in their lives. This may have affected how susceptible they are to interventions, as it has been found that people are more likely to change their habits when they have just moved (Verplanken & Roy, 2016). This raises the question of whether the effects of our intervention can be translated to more stable household settings as well. Nonetheless, this group may be particularly interesting as they constitute the energy users of the future. Another difference with standard household settings is that people usually pay for their energy bill, which was not the case in our experiment as the room rent includes energy and thus eliminates the possibility that monetary concerns guide the behavior change. While the elimination of financial motivations is a specific feature of our “living lab,” this is

different from settings where people do have financial incentives to change their behavior and should be considered when generalizing these findings. That said, previous work has shown (Schwartz et al., 2015) that people care about monetary benefits, irrespective of whether these benefits are made salient or not. This could actually suggest that our manipulations might even be more effective in situations where people do have monetary benefits of acting in a pro-environmental manner, as people can also rationalize their behavior on monetary accounts later on (Thøgersen, 2011). Moreover, a large portion of individual's energy use also occurs in situations where they do not directly pay for their individual energy use, such as at work and in public buildings (Handgraaf et al., 2013). Future research should explore how a similar intervention would work in different settings, such as in an office building or in a household setting.

Another factor in this research that may have influenced behavior is the fact that the people participating in this study were aware of being monitored. Obviously, this may influence the way they acted. However, the fact that participants in the control condition received the exact same information (in terms of the surveys), but not the manipulations, allowed us to control for potential effects that are due to the notion of being monitored. Although we used a control group to control for the potential monitoring effects, it would be of interest to see whether similar results would arise when people are unaware of the fact that they are being monitored. Moreover, in our experiment participants did not explicitly receive information on how much energy they used throughout the experiment, which may make the monitoring issue less salient throughout, as compared to studies using feedback for example (Schultz et al., 2016). Additionally, compared to other intervention studies, our study was less prone to self-selection of participants, as participants were simply approached based on the fact that they were randomly placed in the rooms with measurement equipment and not based on their willingness to participate. Besides, this study was not communicated to participants as a clear energy saving program and it is therefore unlikely that people decided not to participate based on the purpose of the research.

In this study we tested the effect of combinations of construal manipulations on curtailment behavior (i.e., warm water use) and find that especially high construal level combinations are effective. In order to generalize these findings to other types of behaviors that are beneficial to the environment, such as one-off investment decisions, future research is needed. Previous research has shown that low construal level approaches can be effective when targeting one-off decisions (e.g., tax breaks on electric car purchases), but the question often remains whether this has a lasting positive effect on behavior. Future research should investigate whether high construal

level combinations are also more effective when trying to stimulate one-off (investment) decisions, or whether a different approach is more effective.

Finally, we tested two manipulations of construal level, one of which is rather established as a construal level manipulation (viz., the "how versus why" task), whereas the social distance manipulation (viz., the gift to self or other) is less established as such. We argued that the gifts affected the experienced social distance and indirectly people's construal level. However, other explanations can be posed for the congruency between the construal level manipulation and our social distance manipulation. As such, as noted in the introduction, the gifts may have evoked different types of values (i.e., self-interest or pro-social values). We acknowledge that such values could have been at play at the same time but believe that the directionality of the effects would be the same from a values perspective. Moreover, similar to our social distance reasoning and in line with previous work (Goldsmith et al., 2016), we believe that pro-social values are associated with high construal level thinking and self-interest values are more in line with low construal level thinking. In order to tease these two constructs apart, future work could for example focus solely on pro-social values and either represent them at a high construal level or a low construal level. Moreover, it should be tested in future work whether other operationalizations of construal level manipulations have a similar effect on energy saving behavior. Theory suggests that the same effect would emerge when other (combinations of) construal manipulations are used. However, there is simply not enough empirical evidence to make this claim at this point (Griffioen et al., 2016). Therefore, future research should explore the opportunities of combining, for example, a temporal construal manipulation with a hypothetical construal level manipulation. Moreover, it would be very valuable to qualify previous studies based on their construal level and assess whether indeed aligned combinations are most effective in case long-term curtailment behavior is targeted.

4.5.4 Concluding remarks

The aim of this research was to investigate the impact of combinations of intervention approaches. Our research setting allowed us to test the effect of a combination of construal level manipulations on an individual level with objective measurements of energy use. Our findings show that construal level theory can provide a possible explanation for which combinations are most effective. As pro-environmental behavior is about more than just one behavior or just a one-off decision, we studied the effect of our intervention on both the target behavior and other pro-environmental behaviors. Our findings suggest that a congruent

combination at a high construal level has the largest effect on the target behavior and that spillover is most likely to occur when a high construal level approach is used (viz., high social distance). Future work should study how different combinations, based on their level of construal, affect pro-environmental behavior. In sum, our study suggests that when designing interventions one should consider the level of construal of the individual components of the intervention in order to find the most effective way to target pro-environmental behavior.

4.6 Acknowledgements

We thank S.N. Lindhout for helping with the data collection.

4.7 Appendices

Appendix 1. Construal level manipulations.
Appendix 2. Social distance manipulations.
Appendix 3. Initiative of experiment explained.
Appendix 4. Use of objective energy data for analyses.
Appendix 5. Results repeated measures analyses on self-report measures.
Appendix 6. The interaction between the covariates and time in the repeated measures analyses (p-values are reported).
Appendix 7. Main effects in repeated measures analyses on average energy and water use.
Appendix 8. Main effects in repeated measures analyses on the average self-report measures.
Appendix 9. Correlations between self-reported values and measures warm water and electricity use during baseline.
Appendix 10. The effect of time and the interaction between time and the independent variables in the repeated measures analysis on objectively measured water use.
Appendix 11. Absolute change in water use throughout 6-week intervention period compared to baseline.

Appendix 1. Construal level manipulations.

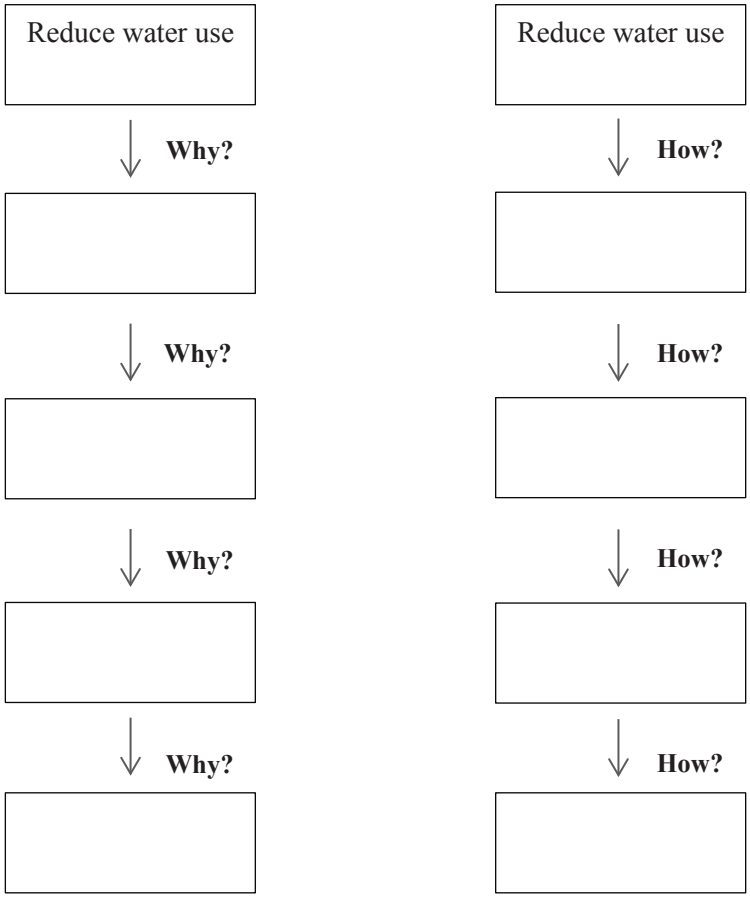
Low construal level condition. Participants in the low construal level condition were asked to consider *how* they could reduce their water use. Participants were asked to read the following instructions:

For everything we do, there always is a process of how we do it. Moreover, we can often follow our broad life-goals down to our very specific behaviors. For example, like most people you probably hope to find happiness in life. How can you do this? Perhaps finding a good job, or being educated, can help. How can you do these things? Perhaps by earning a college degree. How do you earn a college degree? By satisfying course requirements. How do you satisfy course requirements? In some cases, you have to study to pass the course's exam. Research suggests that engaging in thought exercises like that above, in which one thinks about how one's ultimate life goals can be expressed through specific actions, can improve people's life satisfaction. In this study, we are testing such a technique. This thought exercise is intended to focus your attention on how you do the things you do. For this thought exercise, please consider the following activity: "reducing your water use at The Student Hotel to preserve the environment."

High construal level condition. In the high construal level condition participants read a similar passage as the one for the low construal level condition, but with a focus on *why* they would reduce their water use at The Student Hotel to reach important life goals. They read the following instruction:

For everything we do, there always seems to be a reason for why we do it. Moreover, we can often trace the causes of our behavior back to broad life-goals that we have. For example, you might currently be working on an assignment for a course you're following. Why are you doing this? Perhaps to satisfy a course requirement. Why are you satisfying the course requirement? Perhaps to pass the course. Why pass the course? Perhaps because you want to earn a college degree. Why earn a college degree? Maybe because you want to find a good job, or because you want to educate yourself. And perhaps you wish to educate yourself or find a good job because you feel that doing so can bring you happiness in life. Research suggests that engaging in thought exercises like that above, in which one thinks about how one's actions relate to one's ultimate life goals, can improve people's life satisfaction. In this study, we are testing such a technique. This thought exercise is intended to focus your attention on why you do the things you do. For this thought exercise, please consider the following activity: "reducing your water use at The Student Hotel to preserve the environment."

Diagrams. Below are the diagrams participants were asked to complete.



Appendix 2. Social distance manipulations.

Figure A2.1. Gift options in low social distance condition.

The management of The Student Hotel would like to thank you for participating in our new water conservation initiative.

To show you how much we value and appreciate your efforts in helping us to reduce our environmental impacts, we have organized a gift for you. You can choose one gift from the four items below.

Memo alarm clock
Pimp your alarm clock with this Memo alarm clock. You can write or draw on this white alarm clock! This way you can leave memos or use your creativity and draw your own design.

A bottle of wine
You can choose for a bottle of red or a bottle of white wine

Portable External Battery Charger
Recharge your phone or other devices with this small external battery charger by enabling charge speeds of up to 1 amps, add more than a full charge or 4 hours of additional talk time.

Key finder
Never lose your keys again with this key finder. You just whistle and this gadget will light up and make sound.

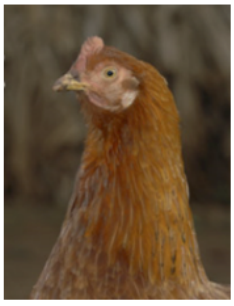
Figure A2.2. Gift options in high social distance condition.

The management of The Student Hotel would like to thank you for participating in our new water conservation initiative.

To show how much we value and appreciate your efforts in helping us to reduce our environmental impacts, we have organized to give a donation on your behalf to a not-for-profit organization. You can choose from one of the causes below you wish to support.

Provide a malnourished child with extra nutritious peanut paste for two weeks
Every day children die because they are malnourished. With this peanut paste they gain weight quickly and increase their resistance to diseases

Fund the shipping costs of approximately 5 books from the US to organizations who request them
These include requests from Peace corps volunteers, libraries and schools all over the world



One chicken for families in Ethiopia, Lesotho, Uganda or Kenya
Chickens provide meat and up to 200 eggs a year - a vital source of protein and income

Provide education for one child for 6 months
With this donation a child in South Africa can go to school for 6 months

Appendix 3. Initiative of experiment explained.

The Student Hotel as a sustainable residence

The Student Hotel is committed to being a sustainable residence. Here at The Student Hotel there are a number of efforts in place to ensure that their carbon footprint is as low as possible. These include investing in energy efficient technology and infrastructure and providing eco-friendly transport for residents.

We ask that you help us to further reduce our environmental impact by participating in our new water conservation initiative. In minimizing your water use in the shower/bath as much as you possibly can, you will help us to ensure that our environmental impact is minimal.

Recap

In this survey we asked you to complete a diagram on why it is important to reduce your water use. Of course, there were no right or wrong answers in this exercise. Below you can find two examples of filled in diagrams from previous research. These diagrams show possible reasons for why it can be important to reduce your water use. [high level]

In the survey we asked you to complete a diagram similar to the diagram below. Below you can find two examples of filled in diagrams. Of course, there were no right or wrong answers in this exercise. The two examples below come from previous research and show possible ways in which you could reduce your water use. [low level]

Figure A3.1 Example diagrams of low construal level condition.

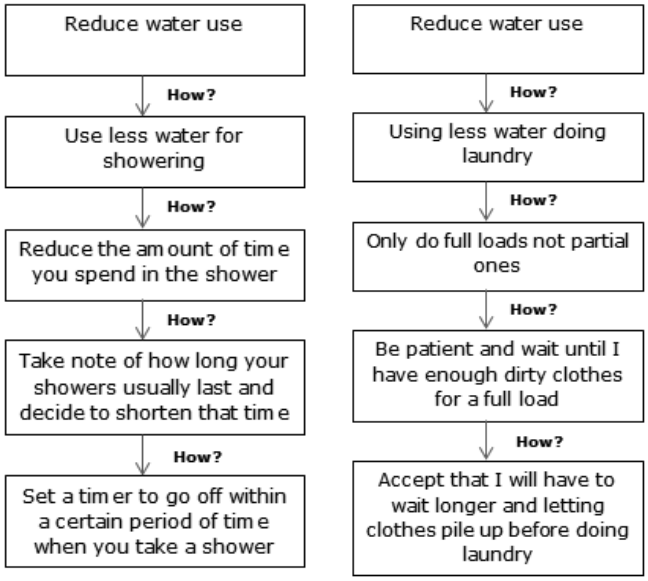
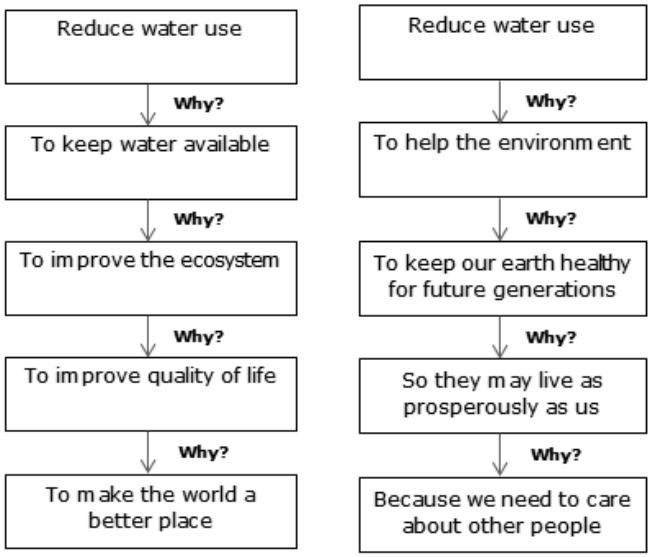


Fig A3.2 Example diagrams of high construal level condition.



Appendix 4. Use of objective energy data for analyses.

In terms of water use, we obtained data on individual hot water usage on a 10-minute basis. Electricity use was measured at two levels; one measurement device measured the automatic lighting in the room which could only be activated when the student's card was in the reader and another device measured the use of the power outlets in the room, which could be used at all times. The electricity data was also measured at intervals of 10 minutes. Finally, the card reader allowed us to see when people were actually in the room. With this measure we could account for individual differences in room use and thus their actual behavior when they were at home.

For analyzing the water data we have computed average water use per week. As participants were not present on all days during the week, we computed the average daily water use for each specific week. We included the water use for a specific day when participants had used more than 5 liters of warm water, as an indication of being present. Outliers (> 2 *SDs*) were replaced with 2 standard deviations from the mean and missing values (due to software problems) were replaced by means of linear interpolation (viz., the average of the two adjacent weeks). Subsequently, in line with Asensio and Delmas (2015), we compared water use with the control group who did not receive any treatment to rule out other influences beyond the intervention. As such, the average daily water use per week per participant is calculated and divided by the average daily water use for that week for the control group, multiplied by a hundred. This number indicates the relative warm water use compared to the control group.

For analyzing the electricity data, we used the presence data detected by the card reader as the indicator for how long people were in the room. We calculated average electricity use per hour present for each week of interest. Similar to the water use, outliers were replaced with two standard deviations from the mean and missing values were replaced by means of linear interpolation. Again, the electricity use was also compared to the control group. As such, the average hourly electricity use per week is divided by the average hourly electricity use for the control group, and multiplied by a hundred.

Appendix 5. Results repeated measures analyses on self-report measures.

Next to the objective measures of water and electricity use, participants were asked to score several statements on their behavior at The Student Hotel. Besides questions on water use behavior, we also asked participants to rate to what extent they engaged in other energy-related behaviors at home, including appliance use and switching off behavior. We ran a repeated measures analysis with the pre- and post-scores as the two levels in the analysis. Additionally, similar to the analyses on the objective measures of energy use, we controlled for wave, age, gender, biospheric values and trait construal level (i.e., BIF).

Self-reported shower behavior. A repeated measures analysis with two levels (pre-intervention and post-intervention score on shower behavior) revealed that time did not have a significant effect on self-reported shower behavior ($F(1,141) = 0.00$, $p = .977$, $\eta_p^2 = .000$).

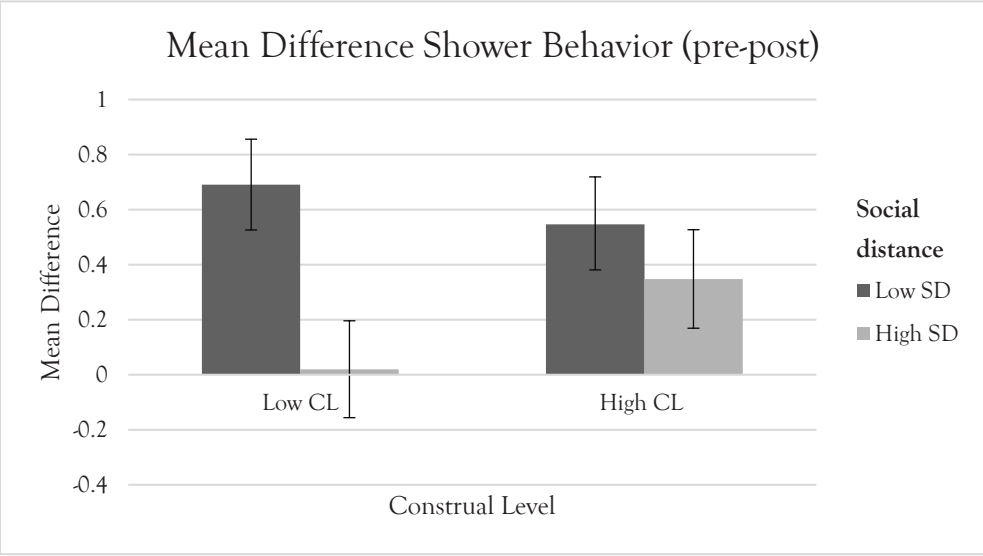


Figure A5.1 Mean difference shower behavior (post-shower behavior minus pre-shower behavior). Higher scores indicate that participants improved on shower behavior. Error bars represent ± 1 SE.

There was a significant interaction between time and social distance on self-reported shower behavior ($F(1,141) = 6.15$, $p = .014$, $\eta_p^2 = .042$); participants in the low social distance condition improved on their shower behavior ($M_{pre} = 3.21$, $SE_{pre} = 0.14$; $M_{post} = 3.83$, $SE_{post} = 0.14$), whereas participants in the high social distance condition only slightly improved on their shower behavior ($M_{pre} = 3.35$, $SE_{pre} = 0.15$; $M_{post} = 3.54$, $SE_{post} = 0.15$). There was not a significant interaction between time and

construal level ($F(1,141) = 0.28$, $p = .595$, $\eta_p^2 = .002$) or between time, construal level and social distance ($F(1,141) = 1.84$, $p = .177$, $\eta_p^2 = .013$).

Self-reported shower time. Participants were also asked for their average shower time and we performed a repeated measures analysis with two levels (pre-intervention and post-intervention shower time). The analysis revealed that construal level significantly interacted with time ($F(1,142) = 6.09$, $p = .015$, $\eta_p^2 = .041$), which indicated that participants in the high construal level condition reduced their self-reported shower time ($M_{pre} = 10.75$, $SE_{pre} = 0.65$; $M_{post} = 9.87$, $SE_{post} = 0.82$), whereas participants in the low construal level condition increased their shower time ($M_{pre} = 11.24$, $SE_{pre} = 0.63$; $M_{post} = 11.98$, $SE_{post} = 0.81$). Time did not have a significant effect on average shower time ($F(1,142) = 0.54$, $p = .465$, $\eta_p^2 = .004$), nor was there an interaction between social distance and time ($F(1,142) = 0.19$, $p = .666$, $\eta_p^2 = .001$), nor an interaction between social distance, construal level and time ($F(1,142) = 2.06$, $p = .153$, $\eta_p^2 = .014$).

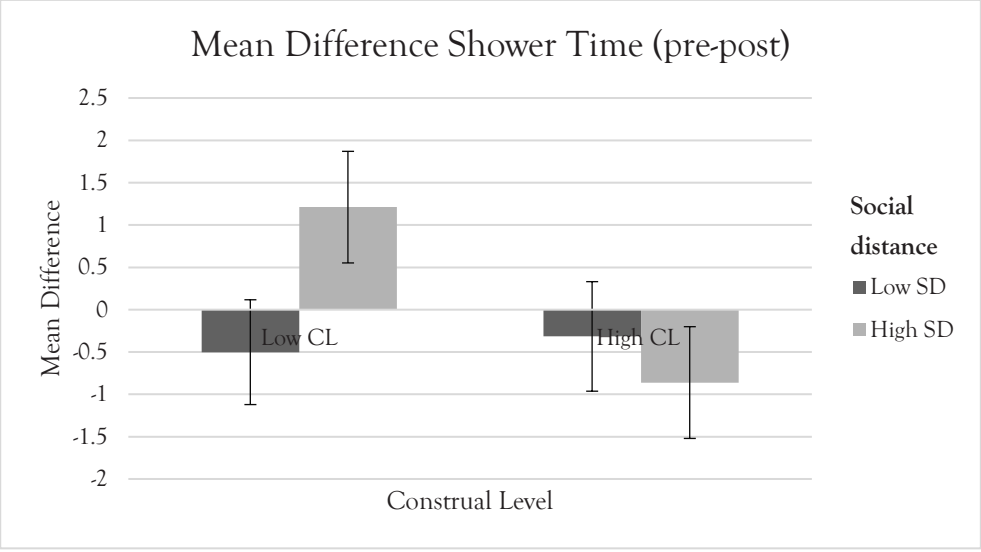


Figure A5.2 Mean difference shower time (post-shower time minus pre-shower time). Higher scores indicate that participants indicated to shower longer in the post-intervention survey. Error bars represent ± 1 SE.

Self-reported appliance use. The analysis revealed that time did not have a significant effect on appliance use ($F(1,141) = 0.63$, $p = .430$, $\eta_p^2 = .004$). There was a significant interaction between time and construal level ($F(1,141) = 4.43$, $p = .037$, $\eta_p^2 = .030$), which indicated that participants in the low construal level condition

improved on their appliance use (M_{pre} = 5.12, SE_{pre} = 0.11; M_{post} = 5.29, SE_{post} = 0.10) and participants in the high construal level condition scored worse on their appliance use in the second survey (M_{pre} = 5.54, SE_{pre} = 0.11; M_{post} = 5.43, SE_{post} = 0.10). There was no significant interaction between time and social distance ($F(1,141) = 0.17$, $p = .678$, $\eta_p^2 = .001$), or between time, social distance and construal level ($F(1,141) = 2.35$, $p = .128$, $\eta_p^2 = .016$).

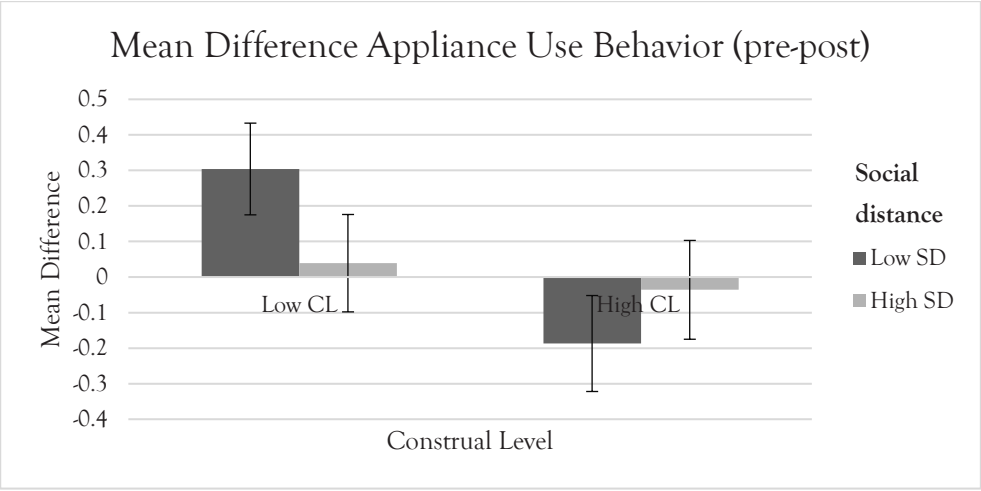


Figure A5.3 Mean difference appliance use (post-appliance use behavior minus pre-appliance use behavior). Higher scores indicate that participants improved on their appliance use behavior. Error bars represent ± 1 SE.

Self-reported switching off. Repeated measures analysis revealed no significant effect of time on switching off behavior ($F(1,141) = 0.02$, $p = .900$, $\eta_p^2 = .000$). Moreover, there were no significant interactions with time: social distance ($F(1,141) = 0.70$, $p = .403$, $\eta_p^2 = .005$), construal level ($F(1,141) = 0.18$, $p = .677$, $\eta_p^2 = .001$), and the interaction between social distance and construal level ($F(1,141) = 0.01$, $p = .932$, $\eta_p^2 = .000$).

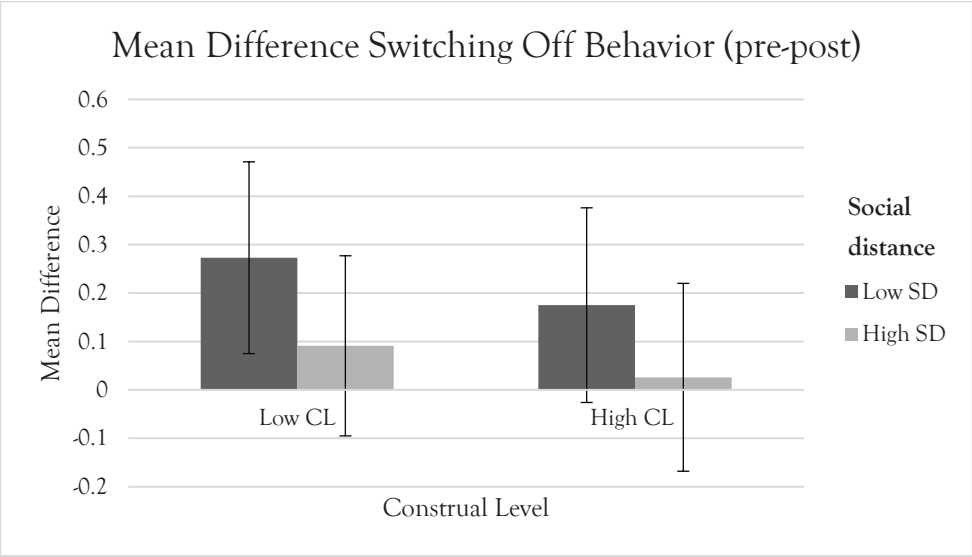


Figure A5.4 Mean difference switching off behavior (post-switching off behavior minus pre-switching off behavior). Higher scores indicate that participants improved on their switching off behavior. Error bars represent ± 1 SE.

Willingness to pay. Next to the effect on the self-reported energy use behavior, we also asked participants how much they would be willing to pay for the gifts they had received (i.e., either the donation or gift to self). Participants were free to indicate how much they were willing to pay, and after replacing the outliers (N = 15) with 2 SDs from the mean, we performed an analysis of variance on willingness to pay. In Figure A5.5, the mean willingness to pay for the gifts can be found. We found a significant effect of social distance, indicating that participants in the high social distance condition were willing to pay more for their gift as compared to participants in the low social distance condition (F(1,133) = 9.51, p = .002, η_p^2 = .067). Additionally, construal level also had a significant effect on willingness to pay (F(1,133) = 10.72, p = .001, η_p^2 = .075), showing that participants in the low construal level condition were willing to pay more for their gift than participants in the high construal level condition. Finally, we also found a marginally significant interaction effect between social distance and construal level (F(1,133) = 3.31, p = .071, η_p^2 = .024), which indicated that participants in the low construal level condition were especially willing to pay more for their gift when they received the gift to other (i.e., large social distance) as compared to when they received a gift to self (i.e., small social distance).

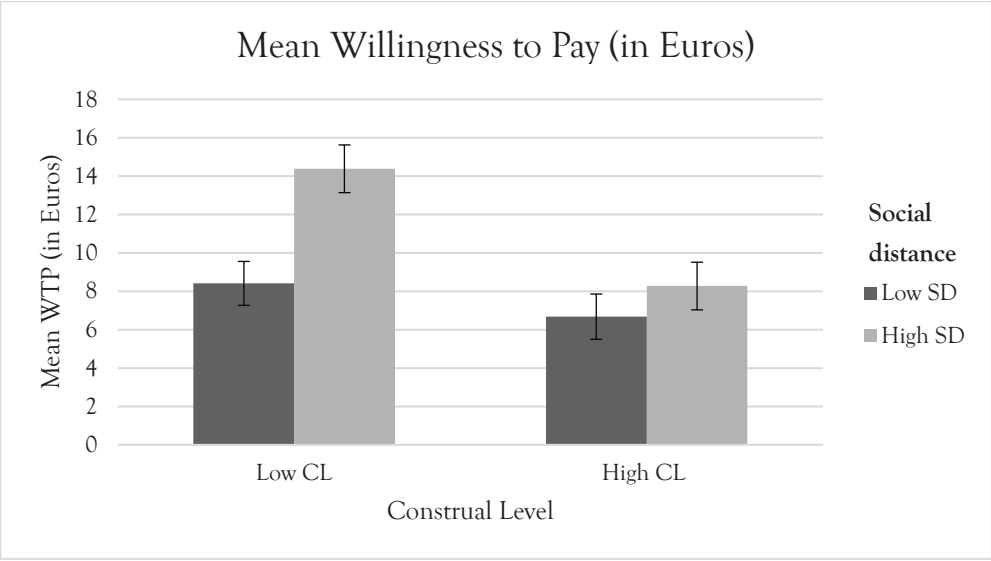


Figure A5.5 Mean willingness to pay for gifts. Higher scores indicate that participants were willing to pay more for the gift. Error bars represent ± 1 SE.

Correlation with water use. As an exploratory analysis, we checked whether participants' willingness to pay for the gift they had received correlated with their water use in week 4. We did, however, not find a significant correlation between willingness to pay and water use in week 4 (Pearson's r = .059, p = .502).

Appendix 6. The interaction between the covariates and time in the repeated measures analyses (p-values are reported)

	Water use			Electricity use		Self-report measures			
Interaction with time	Six weeks	Week 0 vs. week 4	Week 0 vs. week 4 (biospheric values as moderator)	Week 0 vs. week 4 (sockets)	Week 0 vs. week 4 (light)	Shower behavior	Shower time	Appliance use	Switching off
Data collection	.667	.864	.858	.057	.595	.844	.435	.969	.415
BIF	.736	.269	.228	.783	.031[2]	.098	.413	.797	.867
Biospheric	.200	.360	.476	.124	.110	.893	.090	.879	.560
Age	.136	.916	.870	.260	.598	.037[3]	.268	.838	.437
Gender	.984	.558	.810	.004[1]	.063	.371	.015[4]	.204	.867

Note. Significant interactions between one of the covariates and time are depicted in bold.

[1] The significant interaction between time and gender indicated that men did not change their socket use, whereas women increased their socket use.

[2]The interaction between BIF and time indicated that people who scored higher on BIF used more light in week 4 as compared to the week before the intervention (B = 4.81).

[3]The interaction between age and time indicated that older participants reduced their shower behavior more than younger participants (B = 0.05).

[4]The interaction between gender and time indicated that men reduced their shower time (M_{pre} = 10.98, SE_{pre} = 0.67; M_{post} = 10.03, SE_{post} = 0.85), whereas women increased their shower time (M_{pre} = 11.01, SE_{pre} = 0.65; M_{post} = 11.76, SE_{post} = 0.82).

Appendix 7. Main effects in repeated measures analyses on average energy and water use.

	Water (6-week period)			Water (week 0 vs week 4)			Sockets (week 0 vs week 4)			Lights (week 0 vs week 4)		
	$F(1,148)$	p	η_p^2	$F(1,150)$	p	η_p^2	$F(1,130)$	p	η_p^2	$F(1,130)$	p	η_p^2
Intercept	4.15	.043	.027	3.42	.066	.022	3.04	.084	.023	5.77	.018	.042
Wave	0.16	.690	.001	0.10	.754	.001	0.28	.601	.002	2.74	.101	.021
Biospheric	2.71	.102	.018	1.07	.303	.007	0.28	.599	.002	0.01	.930	.000
BIF	0.08	.784	.001	0.22	.644	.001	2.76	.099	.021	2.03	.157	.015
Age	1.69	.195	.011	2.28	.134	.015	0.63	.431	.005	2.34	.128	.018
Gender	0.45	.502	.003	0.36	.552	.002	1.96	.164	.015	0.01	.941	.000
Social distance	0.39	.532	.003	0.12	.734	.001	1.04	.310	.008	0.00	.999	.000
CL	0.22	.644	.001	0.14	.710	.001	2.98	.087	.022	0.55	.460	.004
Social distance*CL	1.01	.317	.007	0.73	.396	.005	0.30	.588	.002	0.71	.401	.005

Note. CL = Construal level. The average use for the six-week period as a dependent measure is shown in the first column and the average use of week 0 and week 4 is shown as the dependent measure in the latter three columns.

Appendix 8. Main effects in repeated measures analyses on the average self-report measures.

	Shower behavior			Shower time			Appliance use			Switching off		
	$F(1,141)$	p	η_p^2	$F(1,142)$	p	η_p^2	$F(1,141)$	p	η_p^2	$F(1,141)$	p	η_p^2
Intercept	0.89	.346	.006	8.45	.004	.056	6.77	.010	.046	1.10	.297	.008
Wave	4.38	.038	.030	3.49	.064	.024	2.61	.108	.018	2.23	.137	.016
Biospheric	9.21	.003	.061	0.37	.546	.003	23.32	.000	.142	19.56	.000	.122
BIF	0.17	.683	.001	0.73	.396	.005	2.18	.142	.015	0.05	.818	.000
Age	15.98	.000	.102	0.17	.685	.001	6.51	.012	.044	11.39	.001	.075
Gender	0.15	.704	.001	0.41	.523	.003	4.12	.044	.028	0.40	.526	.003
Social distance	0.18	.670	.001	1.13	.291	.008	1.83	.178	.013	0.001	.976	.000
CL	1.96	.163	.014	1.75	.188	.012	4.27	.041	.029	1.63	.204	.011
SD × CL	0.36	.553	.003	0.83	.364	.006	3.05	.083	.021	1.64	.203	.011

Note. CL = construal level manipulation, SD = social distance manipulation. Average of pre- and post-intervention survey scores taken as dependent measure.

Appendix 9. Correlations between self-reported values and measures warm water and electricity use during baseline.

	Objective measures			Self-report measures									
	Water	Sockets	Light	Shower time	Shower behavior	Appliance use	Switching off	Hedonic	Egoistic	Altruistic	Biospheric	Efficacy	Env. identity
Sockets	.137*	-											
Light	.191**	.375***	-										
Shower time	.354***	−.031	−.015	-									
Shower behavior	−.142**	−.045	.054	−.283***	-								
Appliance use	−.064	−.212***	−.139*	−.229***	.441***	-							
Switching off	−.074	−.215***	−.174**	−.119*	.360***	.453***	-						
Hedonic	−.026	.009	.008	.003	−.159**	−.051	−.038	-					
Egoistic	.004	.070	−.002	.025	−.118*	−.087	.005	.434***	-				
Altruistic	−.061	.070	.032	−.115	.102	.114	.142**	.314***	.208***	-			
Biospheric	−.011	.028	−.036	−.074	.271***	.359***	.308***	.268***	.145**	.704***	-		
Efficacy	−.015	.035	.036	−.026	.241***	.287***	.247***	.029	.043	.256***	.250***	-	
Env. Identity	−.102	−.060	−.156**	−.159**	.396***	.459***	.386***	−.116	−.040	.126*	.437***	.235***	-
BIF	.044	.212***	.068	.068	.131*	.186***	.110	−.046	.006	.081	.128*	.156**	.152**

Note. * $p < .10$, ** $p < .05$, *** $p < .01$

Appendix 10. The effect of time and the interaction between time and the independent variables in the repeated measures analysis on objectively measured water use

	Baseline vs. Week 1			Baseline vs. Week 2			Baseline vs. Week 3			Baseline vs. Week 5		
	$F(1,158)$	p	η_p^2	$F(1,152)$	p	η_p^2	$F(1,152)$	p	η_p^2	$F(1,148)$	p	η_p^2
Time	1.17	.280	.007	0.50	.479	.003	0.19	.668	.001	3.89	**.050**[1]	.026
Time × Wave	1.98	.161	.012	0.01	.930	.000	0.07	.786	.000	0.04	.834	.000
Time × Biospheric	0.72	.398	.005	1.10	.295	.007	2.19	.141	.014	5.25	**.023**[2]	.034
Time × BIF	0.03	.858	.000	0.17	.677	.001	0.12	.734	.001	0.09	.771	.001
Time × Age	1.88	.173	.012	3.49	.064	.022	0.42	.520	.003	0.73	.396	.005
Time × Gender	0.05	.823	.000	0.56	.455	.004	0.01	.936	.000	0.22	.642	.001
Time × SD	0.30	.586	.002	0.31	.577	.002	0.18	.670	.001	0.01	.920	.000
Time × CL	0.003	.955	.000	0.47	.493	.003	0.49	.486	.003	0.45	.504	.003
Time × SD × CL	0.36	.547	.002	1.21	.273	.008	2.37	.126	.015	0.63	.429	.004

Note. CL = construal level manipulation, SD = social distance manipulation. Significant effects are depicted in bold.

[1]The significant interaction of time in week 5 indicated that (compared to the control group) all participants used less water as compared to the baseline period.

[2]The interaction between biospheric values and time indicated that the higher people scored on biospheric values the more water they used in week 5 as compared to baseline (B = 2.69).

Appendix 11. Absolute water use throughout 6-week intervention period.

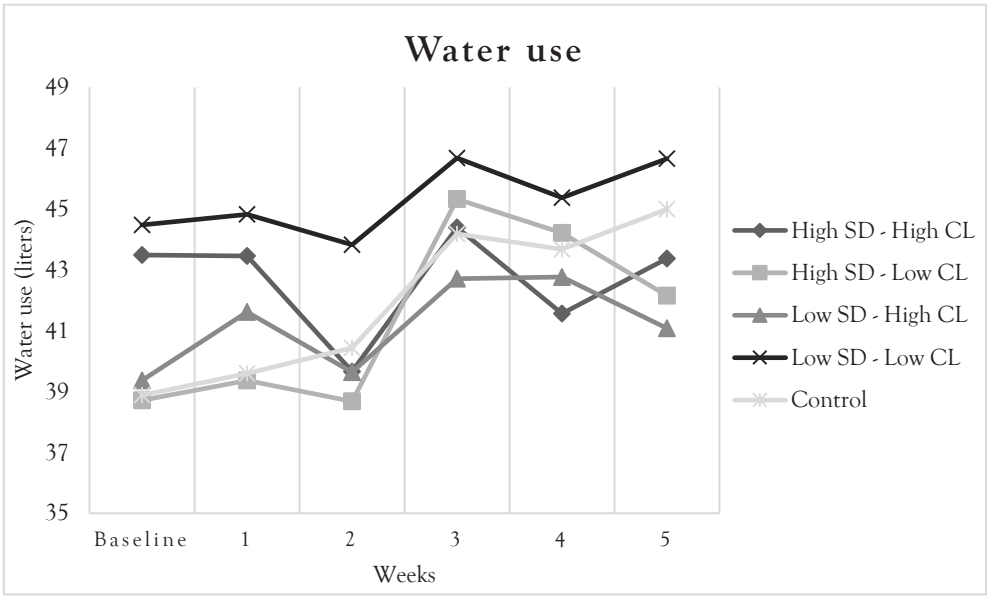


Figure A11.1 Absolute water use in liters during six-week intervention period. CL = construal level, SD = social distance

Chapter 5

The how and why of shorter showers: Long-term effects of construal level and real-time feedback on energy conservation

This chapter is based on Griffioen, A. M., Handgraaf, M. J. J., & Antonides, G. (*manuscript in preparation for submission*). The how and why of shorter showers: Long-term effects of construal level and real-time feedback on energy conservation.

Abstract

One challenge within the domain of pro-environmental behavior is designing interventions with a lasting impact. When forming a new habit, people may focus on concrete features of the behavior and think of how to perform it. Alternatively, they can think of underlying reasons by thinking of why they should perform it. This distinction is captured in construal level theory. We investigated whether receiving real-time feedback about (warm) water use in the shower for one month had lasting effects on behavior. We hypothesized that low construal level thinking would be effective for short-term behavior change and high construal level thinking for long-term change. We ran an experimental field study at an all-inclusive student housing facility, where we could measure individual daily energy and water use over a three-month period. 92 participants were randomly assigned to the high or low construal level condition and filled out pre and post intervention surveys. We found that all participants significantly reduced their water use when receiving real-time feedback. After one month, we uninstalled the real-time feedback device and measured participants' water use for another month; all participants used significantly less water as compared to the baseline period. Moreover, participants in the high construal level condition who highly valued the environment used less water in the period after the feedback device was taken away as compared to those in the low construal level condition. These findings add to research on habit formation and how this is affected by construal level.

Keywords: construal level theory, real-time feedback, water use, energy use, spillover behavior

5.1 Introduction

One challenge for policymakers within the domain of pro-environmental behavior is to not only change one-off decisions or realize short-term behavior change, but to have a lasting impact on individual day-to-day decisions and habitual behavior. Although habits have a persistent effect on pro-environmental behavior (Verplanken & Roy, 2016), the formation and maintenance of these habits have been studied less (Abrahamse et al., 2005; Lally & Gardner, 2013). Before behavior becomes habitual, mental processes play an important role in the type of association people make between the situational cue and the response to a specific cue (i.e., the behavior). In this research we argue that the construal level (Liberman & Trope, 1998; Trope & Liberman, 2003) at which people initially think about behavior change influences whether the behavior ultimately becomes habitual. Construal level theory poses that at a low construal level people think more about how to perform the new behavior, whereas a high construal level enables people to think about the reasons why they should perform the new behavior. Construal level in turn influences the way people make decisions, and behave, and may thus influence whether newly adopted behaviors become habitual.

As people can be motivated to start a new behavior by knowing how they could do it or why they should do it, this research aims to investigate which one method has more lasting effects. We focus on a very habitual behavior at home: Shower behavior. To instigate the behavioral change, we randomly assign participants to a high or low construal level manipulation and give them real-time feedback on their shower use for one month. After one month, the feedback device is removed, and we test whether a high or low construal level manipulation has a more lasting effect on shower behavior and other related pro-environmental behavior. During the experiment we objectively measure individual daily water and energy use before, during and after the installation of the real-time feedback device. In the following we will first review literature on the effects of habits, real-time feedback and construal level theory on pro-environmental behavior.

5.1.1 Habits

Many habitual day-to-day activities have an impact on the environment; going to work by car, using the washing machine for small loads, not switching appliances completely off, and taking long and hot showers. At some point in time, all types of behaviors have been initiated and by repeatedly engaging in the same behavior it eventually becomes a habit. Early work on habits simply defined habits as frequently engaging in the same behavior (see Verplanken, 2006). However, more recent work

on habits suggests that habits involve an automaticity aspect. Therefore, we define habits as the automatic response to a situational cue (Verplanken, 2006; Wood & Neal, 2007). Specifically, habits are formed by strengthening the relation between a specific situation (usually referred to as a cue) and the behavior (or action). This means that when someone repeatedly engages in a certain behavior in the same context, the behavior becomes more automatic. Habits are functional, as people do not have to consciously make decisions every time they are faced with that specific decision. At the same time, strong habitual patterns make it harder to change current environmentally-harmful behavior into more environmentally-friendly behavior (Biel & Dahlstrand, 2005).

Even though people are relatively easily persuaded to change their attitudes or intentions, actual behavior change is harder to establish especially when this concerns habitual behavior in stable contexts (Dahlstrand & Biel, 1997). In order to change behavior, old habitual patterns must first be broken before new habits can be formed (Jakovcevic et al., 2014). One way to break old habitual patterns is to change the context in which the behavior is usually performed, which is consistent with the habit discontinuity hypothesis (Verplanken & Roy, 2016; Verplanken, Walker, Davis, & Jurasek, 2008). Contextual changes can be something rather big, such as a move to a different city (Verplanken et al., 2008) or something smaller that is related to the cues that trigger the habitual behavior, such as a display that gives direct feedback on energy-related behavior. In the specific case of shower behavior, providing people with feedback can be especially effective as it directs their attention to the problem, increases the consciousness of the relevance of their shower behavior, and increases their sense of control (Fischer, 2008).

5.1.1.1 Real-time feedback and habits

The effectiveness of feedback on energy use has been extensively studied in the past, with effectiveness ranging from increased energy use up to 8% to decreased energy use up to−20% (Allcott, 2009, 2011; Allcott & Rogers, 2012; Asensio & Delmas, 2015; Delmas et al., 2013; Handgraaf et al., 2013; Schultz et al., 2015; Tiefenbeck et al., 2016; van Houwelingen & van Raaij, 1989). Previous research suggests that it is most effective when feedback is given automatically and during the occurrence of the behavior (Fischer, 2008; Hermsen, Frost, Renes, & Kerkhof, 2016). Moreover, studies that have focused on feedback targeted at shower behavior have shown that real-time feedback can indeed significantly reduce energy use in the shower (Kappel & Grechenig, 2009; Kuznetsov & Paulos, 2010; Tiefenbeck et al., 2016; Willis, Stewart, Panuwatwanich, Jones, & Kyriakides, 2010). Apart from the study by

Tiefenbeck et al. (2016), most studies have had a limited number of participants in the feedback condition and suffer from self-selection problems, which makes it difficult to generalize findings. The first aim of the current study is, therefore, to replicate the previous finding that providing real-time feedback can indeed reduce shower time and test this in a relatively controlled setting with a sufficient sample size.

It has been established that providing real-time feedback is very effective while the feedback is in place. The question, however, remains whether the feedback is constantly needed or whether people at some point stop noticing the feedback device and have simply changed their shower habit. In the latter case, they may not consciously think about the duration of their shower any more. Determining how long it takes before a behavior is performed automatically and without conscious thought is not easily measured by either self-report or objective measures. Previous research on self-monitoring of electricity use has shown that after a short period of time (i.e., a week) people are less inclined to look at the monitor and the authors therefore concluded that self-monitoring devices only need to be installed for a short period of time (Webb, Benn, & Chang, 2014). This finding bears promise in terms of changing habits in a relatively short period of time, but previous research has often failed to measure energy consumption after the self-monitoring or feedback device had been removed. This raises the question of whether it is important that the device is in place, that people feel that they are being monitored and know that they can consult the device for the right information, or that after a short period of time they do not need the device or the information it conveys any longer. In this study we specifically address this question.

As habits entail this automaticity component, it does seem to be important how people actually start a new behavior (that will eventually become a habit) and previous research suggests that habit formation is mediated by mental processes (Aarts, Verplanken, & Knippenberg, 1998), associating the given situation or environmental cue (that triggers the behavior) with the specific action someone takes in that situation. The more often someone engages in the behavior, the more one tends to think about the behavioral action. This also suggests that how people think about performing the behavior in the first place and what goal this behavior serves is important in how they think about the behavior when it is performed on a repeated basis. In the case of reducing one's water use, someone may think about solely reducing water use and attaining this goal can be accomplished by taking shorter showers. Every time someone showers, the goal of reducing water use is triggered and when the behavior has become a habit, someone will not consciously evaluate other factors that may influence how long someone should shower. Alternatively, someone may decide to take shorter

showers for the purpose of decreasing their impact on the environment. This serves a broader goal and every time someone takes a shower this serves the goal of decreasing their environmental impact. This also suggests that when other behaviors are also associated with reducing its impact on the environment, other habitual behaviors may be triggered and lead to positive spillover, such as always switching off the light or unplugging devices.

5.1.1.2 Construal level and habits

The fact that habitual behavior can be initiated by aiming for different goals, begs the question of what is most effective in creating long-lasting pro-environmental habits. We, therefore, study the effect of construal level on the formation and maintenance of habits. According to Construal Level Theory (Liberman & Trope, 1998; Trope & Liberman, 2003), people can think at different levels of abstraction. In the previous example of taking shorter showers, solely thinking about reducing water use is a very concrete goal, whereas thinking about decreasing one's impact on the environment is a rather abstract concept. Thinking at a more abstract level corresponds to a high construal level. An example of abstract thinking has often been related to *why* one would engage in certain behavior, focusing on the underlying reasons on why people behave the way they do. In contrast, thinking at a more concrete level corresponds to a low construal level, related to *how* one can perform certain behavior (Freitas et al., 2004). Previous research indicates that whether someone thinks at a high or low construal level can influence pro-environmental behavior (Fujita et al., 2013; Griffioen et al., 2016). As such, at a high construal level behavior is mostly guided by inner values and desirability concerns (Hunt et al., 2010), whereas low construal level thinking makes people focus more on the situation itself and how feasible the behavior is (Liberman & Trope, 1998; Trope & Liberman, 2010).

Based on construal level theory, we expect that whether someone thinks at a high or low construal level influences how they respond to real-time feedback. At a low construal level, we expect people to play close attention to the device and the detailed information it conveys. More specifically, we expect that the cue that triggers their automatic shower behavior (i.e., their routine, duration, flow rate) will be the real-time feedback device. In contrast, high construal level thinking will shift the focus of the shower behavior more to the desirable end-state the real-time feedback device serves. In other words, the real-time feedback is more a means to an end, and not an end in itself and people are more likely to focus on the desirable end state (Fujita et al., 2008; Liberman & Trope, 1998). We, therefore, expect that real-time feedback will be

effective among all participants, but that the level of water use reduction depends on construal level. We expect that low construal level thinking will make people focus more on the feedback device and thus take more of the information into consideration when taking a shower. Therefore, we expect that real-time feedback will be more effective for people who are asked to think at a low construal level as compared to those who are asked to think at a high construal level about their water use.

At the same time, for behavior to be truly environmentally friendly, the intervention should have long-lasting effects on behavior and thus create a shorter shower habit also when feedback is no longer provided (or necessary). Research on what happens to behavior after (real-time) feedback is no longer provided is limited (Abrahamse et al., 2005). While receiving feedback, people are expected to change their behavior into a more energy-conscious behavior. Following the logic by van Houwelingen and van Raaij (1989), it could be that repeatedly reducing one's energy use in the shower creates new attitudes or enhances pre-existing attitudes towards the environment. We extend this logic, by arguing that whether the association between values and behavior is actually internalized depends on their construal level. Specifically, we expect that behavior will be more internalized when someone thinks at a high construal level. Research suggests that thinking at a high construal level enables people to act more upon their inner values and render them less affected by situational changes (Eyal et al., 2009; Fujita et al., 2008). Therefore, when people change their shower behavior after receiving real-time feedback for one month and think about this behavior at a high construal level, they may be less affected by the fact that they do not longer see the feedback device and receive feedback. Reducing one's time in the shower serves a higher goal (i.e., desirable end-state they want to reach) and having established a shorter shower habit serves this purpose. We thus expect that high construal level thinking will result in a long-lasting change in shower habit. This is in contrast to people who think about their shower behavior at a low construal level. As low construal level thinking makes people more susceptible to be influenced by contextual cues and changes; the removal of a device that provides them with the right information to act upon may take away their instrument that enables them to take shorter showers. Moreover, the device may become the environmental cue that triggers the behavior (i.e., taking shorter showers). We, therefore, expect that people who think at a low construal level are less likely to maintain a shorter shower habit, and more likely to return to their initial water use level.

5.1.2 Biospheric values

As construal level theory poses that high construal level thinking enables people to act more upon their inner values, it is important to take these values into account when assessing the effectiveness of receiving feedback. In terms of environmentally-friendly behavior, studies have shown that how much people value the environment is an important indicator of actual behavior (de Groot & Steg, 2008; van den Broek et al., 2017; van der Werff et al., 2014a). In terms of current water use, it may thus be important to also take environmental values (i.e., biospheric values) into consideration. Values are considered to be rather stable characteristics that do not change very much over time (Schwartz, 1992). Considering that people have formed a shower habit at some point in their life, we expect that those who indicate to highly value the environment will act in line with their values and use considerably less water than those who score lower on biospheric values before the intervention.

Besides the fact that people who value the environment may use less water and energy in the baseline period, we anticipate that the degree to which people value the environment will also influence how they respond to feedback. A recent review on feedback studies across different domains has highlighted that individual differences are often disregarded, whereas this may be a very important aspect that may determine whether people are willing to conserve energy or not (Hermsen et al., 2016). We expect that people who value the environment a lot can respond in one of two ways. Some research seems to suggest that those who care a lot about the environment are influenced more by environmental campaigns as it corresponds to their values (van den Broek et al., 2017). This would also be in line with construal level theory, indicating that when people think at a high construal level, they act more in line with their values, and may thus be more willing to reduce their water use. In direct contrast to this, one could also argue that those who value the environment a lot are influenced less by environmental campaigns, as they already act in a more environmentally-friendly manner and thus have less room for improvement (Griffioen, Handgraaf, & Antonides, under review; Ruepert, Keizer, & Steg, 2017). Moreover, previous work has shown that people who use more in the baseline period are likely to reduce their water use more (Tasic et al., 2012). We expect that environmental values will indeed affect baseline water use (i.e., use less water), and, therefore, we anticipate that those who value the environment less have more "room for improvement" and will be able to reduce their water use more.

5.1.3 Spillover and net environmental impact

Finally, pro-environmental behavior is a broadly defined topic and cannot be limited to one behavior only. If people do well on one particular pro-environmental behavior (e.g., reduce their water use) it is also important to study how this affects other pro-environmental behaviors (e.g., electricity use, recycling behavior). This is often referred to as spillover behavior (Thøgersen & Ölander, 2003) and taking the effect on all different environmental behaviors together is sometimes referred to as the net environmental impact (Truelove et al., 2014). For example, when people reduce their water use, but at the same time start using more electricity, the overall net environmental impact of an intervention is limited. Moreover, as we are interested in the overall effectiveness of our intervention, we also want to detect how it affects other energy-related behaviors. Based on construal level theory we expect that participants in the high construal level condition will be more likely to think about the overall implications of their behavior, as we expect them to have a broader focus on doing something for the environment (which is not solely limited to water use behavior).

5.1.4 Current research

This study was designed to test the long-lasting effects of a construal level manipulation on a newly formed habit. Construal level was manipulated with an adjusted version of the "how versus why" task designed by Freitas, Gollwitzer, and Trope (2004). To create a new shower habit, we installed devices that gave participants real-time feedback about their water use (Amphiro device; for the full description of the device, see Tiefenbeck, Goette, Degen, & Tasic, 2016), which has led to more than 20% energy savings in previous experiments. The current study aims to add to current findings in four ways. First of all, we want to replicate the finding that real-time feedback can lead to energy and water savings. Secondly, and in contrast to previous studies, we want to study whether taking shorter showers becomes a lasting habit after participants do not receive real-time feedback any longer and whether this is contingent on the construal level manipulation. Thirdly, we are interested in the moderating effects of biospheric values on habit formation. Lastly, we want to study the effect of receiving real-time feedback in combination with a construal level manipulation on related energy-use behaviors and thus measure the overall impact of the intervention. To test these four goals, we ran a field experiment at a student housing facility that provides all-inclusive rooms to students for one or two semesters. In a number of rooms, we have installed detailed measurement equipment that unobtrusively measures water use, electricity consumption and presence in the room.

This data enabled us to compare the water use in the period before the device was installed to the period the device was in place, and to the use in the period after the device was taken away. This is in contrast to earlier studies, that have always recorded the water use with the feedback device itself, which makes it unclear whether the detected effects are solely due to the fact that people are aware of being monitored.

In sum, basing ourselves on previous findings, we created the following hypotheses (pre-registered at aspredicted.org):

Hypothesis 1: When participants receive real-time feedback, they reduce their water use as compared to baseline.

Hypothesis 2a: Participants in the low construal level condition reduce their water use more than participants in the high construal level condition while receiving real-time feedback.

Hypothesis 2b: Participants in the high construal level condition maintain a 'shorter shower' habit more than participants in the low construal level condition when real-time feedback is no longer given.

Hypothesis 2c: Participants in the low construal level condition will return to their initial shower time when real-time feedback is no longer given.

Hypothesis 3a: Participants who score higher on biospheric values use less water in the baseline period.

Hypothesis 3b: Participants who score lower on biospheric values are more susceptible to the high construal level manipulation in (1) reducing their water use and (2) maintaining their habit.

Hypothesis 4: Participants in the high construal level condition will show more positive spillover behavior than participants in the low construal level condition.

5.2 Methods

Participants. 92 participants (M_{age} = 19.58, SD_{age} = 1.92, 52.2% female) were recruited to participate in this research in March 2017. Students staying in rooms with measurement equipment (N = 138) were contacted and asked to participate in this study. We were dependent on students being present during the period we approached them, which resulted in a 67% response rate (11% rejected to participate and 22% were unavailable). Participants were asked to fill out two surveys and having the real-time feedback device installed in their shower for one month. In the first survey, participants were randomly assigned to one of two conditions: low construal level or high construal level.

Procedure. Students staying in rooms with measurement equipment were first contacted via email, announcing that a research team from Wageningen University was conducting research at the student housing facility they were living and that a researcher would come by the following week to ask them to participate in this study. In this email, it was also communicated to students that when participating in this research they would get a "shower gadget", providing them with real-time feedback on their shower behavior. We decided not to specifically communicate energy saving to avoid self-selection problems. The following week, a researcher approached students face-to-face to install the device and asked them to fill out a short survey. Students were first asked to read the informed consent form, in which it was clearly communicated, next to the standard matters (voluntary participation, and confidentiality and anonymity of data), that their individual answers in the questionnaire would be linked to objective measurements of their energy and water use. All participants agreed to this, started the questionnaire and a researcher started the installation of the device in the shower. After completing the survey, participants were informed that the device would be taken out after one month and that upon removing the device they would be asked to fill out another survey. After the device had been removed, participants were thanked for their participation.

Materials. Participants were asked to fill out one survey while the device was being installed, and one survey when the device was taken out again (see Table 1 for means and standard deviations and Appendix 3 for the same table split by condition). Both surveys included questions on trait construal level, perceived sustainability of the student housing facility, pro-environmental behavior and values. The second survey also included questions on the use of the real-time feedback device. Unless otherwise indicated, participants were asked to score all statements or questions on 7-point Likert-type items (1 = *strongly disagree*, 7 = *strongly agree*).

Trait construal level. We used 10 items from the Behavior Identification Form (BIF; Vallacher & Wegner, 1989) as a measure of trait construal level. Participants were presented with 10 different behaviors and were asked to select one of two descriptions that seemed most suitable to them. One description represents a more concrete description of the behavior and the other one is more abstract. For example, participants were asked to choose between "preventing tooth decay" (abstract) and "moving a brush around in one's mouth" (concrete) as the most fitting description for "tooth brushing." Abstract items were scored as 1 and concrete items as 0, with higher scores thus indicating more abstract thinking.

Sustainability of student housing facility. We included three items to assess how participants thought about the sustainability efforts of the student housing facility (e.g., "The Student Hotel is a sustainable residence").

Energy use behavior. We also asked participants to indicate how much they were engaged in energy saving behavior on a 7-point frequency scale (1 = *never,* 7 = *always*). Four items assessed their shower behavior (e.g., "I limit the time I spend in the shower"), three items their energy use behavior (e.g., "When there is nobody in the room I switch off the light"), and one item on their shower habit ("I consciously think about the duration of my shower").

Values. To assess personal values, and especially biospheric values, we asked participants to rate items from Schwartz's value scale (1992) on a 9-point importance scale (−1 = *opposed to my principles,* 0 = *not important,* 7 = *extremely important*). Based on earlier work by de Groot and Steg (2008) we included four items for biospheric values (e.g., "PREVENTING POLLUTION: protecting natural resources"), four items for altruistic values (e.g., "HELPFUL: working for the welfare of others"), five items for egoistic values (e.g., "WEALTH: material possessions, money"), and three items for hedonic values (e.g., "SELF-INDULGENT: doing pleasant things").

Construal level manipulation. Participants were asked to fill out an adjusted version of the "how versus why" task (Freitas et al., 2004; see Chapter 4). Participants were randomly assigned to either the how task (low construal level) or the why task (high construal level). This task was designed to vary the level of abstraction at which participants thought about one activity, in this case their water use, which is a commonly used manipulation of construal level (for full description of the task see Chapter 4). After the construal level manipulation we asked participants on a bipolar 7-point scale whether the task was "difficult to process/easy to process" and "difficult to understand/easy to understand" (Lee & Aaker, 2004).

Demographics. We asked participants for their age, gender, nationality and current education level.

Post-intervention survey. In the post-intervention survey participants were again asked to fill out the items on trait construal level, perceived sustainability of the student housing facility, energy use behavior and values. Participants were not asked to fill out the construal level manipulation again or for their demographic information. We did ask participants a number of questions on the use of the feedback device for additional exploratory analyses. Participants were asked whether the feedback device failed during the study period and if so, what happened (open-ended question; 0% failed). Moreover, participants were asked to fill out four items

to indicate how well the device functioned during the study period ("The device was easy to read" (*M* = 6.34, *SD* = 0.76), "I stopped noticing or paying attention to the device after a while" (*M* = 3.34, *SD* = 1.74), "I liked the information the device showed me" (*M* = 5.87, *SD* = 0.92), and "The information provided on the display made me feel guilty" (*M* = 5.16, *SD* = 1.46). Additionally, we asked participants whether they set a goal for themselves during the study period (75% set a goal), and if so, what that goal was (open-ended question). Finally, we asked participants to indicate how much they thought their energy and warm water use had increased because of visitors over the past month on a 7-point frequency scale (1 = *not at all*, 7 = *very much*; *M* = 3.70, *SD* = 1.66). For the same purpose, we also asked participants to indicate the percentage of energy and warm water use in their room was consumed by them (1-100%), with 100% indicating that they had used all the energy and warm water by themselves and 0% indicating that all the energy and warm water in the room was used by others (*M* = 72.03, *SD* = 18.16).

Table 1 *Means, standard deviations, and reliability of self-reported survey items in pre- and post-survey*

	Pre-intervention survey			Post-intervention survey		
Self-report measures	*M*	*SD*	α	*M*	*SD*	α
Trait construal level	0.56	0.23	.634	0.59	0.23	.623
Perceived sustainability	4.38	1.28	.802	4.58	1.33	.879
Energy conservation behavior						
Shower	2.99	1.13	.527	3.32	1.26	.692
Electricity	4.45	1.17	.393	4.49	1.26	.606
Shower habit	3.78	1.79	-	4.45	1.49	-
Values						
Hedonic	5.47	1.16	.780	5.31	1.16	.792
Egoistic	4.06	1.06	.610	3.99	1.00	.594
Altruistic	5.70	0.94	.654	5.55	0.97	.701
Biospheric	5.45	1.12	.784	5.31	1.07	.821

Amphiro device. While participants were filling out the pre-intervention survey, a researcher installed the Amphiro device in their shower. The device is powered by the flow of water and displays the following information during the shower: energy label, temperature of water, energy consumption (i.e., to heat up the water), number of liters and a polar bear animation (see Tiefenbeck et al., 2016). When participants

were filling out the post-intervention survey, the researcher removed the Amphiro device from their shower.

Objective measures of energy use. Participants who participated in this research stayed in rooms, outfitted with equipment that measures electricity use (separately for light and socket use), warm water use and presence (by means of a card reader). Data was recorded at a 10-minute interval and we used daily electricity and warm water consumption as our unit of measurement. We used the data one month prior to the installation of the feedback device, during the study period, and one month after the feedback device had been taken out again. We explored the distribution of the data and found a number of outliers. In terms of water use, one participant significantly deviated in terms of its water use from all other participants and we were suspicious of the person not staying in the room alone. For all other data we used the following method to detect and replace outliers. We specified outliers as those values that were greater than 1.5 times the interquartile range (Q3-Q1) above the third quartile. Outliers were then replaced with the value that was 1.5 times the interquartile range above the third quartile (Cohen et al., 2003). We used the same method for electricity use. When the outliers were replaced, the data approximated a normal distribution and did not show a clear deviation from homoscedasticity.

5.3 Results

5.3.1 Confirmatory analyses

We used the R package *lme4* (Bates, Mächler, Bolker, & Walker, 2014; R Core Team, 2017) to perform a linear mixed model analysis of the relationship between the construal level manipulations in combination with feedback on daily water use throughout the experiment. As fixed effects, we included dummies for the how and why conditions in the model (while controlling for the time component), as well as biospheric values in the extended model. We employed a random intercept per participant, allowing for baseline differences in water use.

Water use. We used equation 1 to detect the effectiveness of the feedback in combination with the construal level manipulation during the different intervention periods.

(1) $$y_{it} = \alpha_i + \beta_1 CLT + \beta_2 W_{1it} + \beta_3 H_{1it} + \beta_4 W_{2it} + \beta_5 H_{2it} + \beta_6 W_i * T_{1it} + \beta_7 W_i * T_{2it} + + \beta_8 W_i * T_{3it} + \beta_9 H_i * T_{1it} + \beta_{10} H_i * T_{2it} + \beta_{11} H_i * T_{3it} + \varepsilon_{it}$$

To account for baseline differences in water use, α_i represents the random intercept for each participant. CLT is a binary dummy variable for the construal level manipulation, with 0 for the How condition and 1 for the Why condition, indicating the main effect of condition on overall water use throughout the three-month study period. The indicators for W_1 and H_1 are zero for the first 30 days of the experiment (the baseline period) and the last 30 days of the experiment (the post-intervention period) and are set to 1 in the intervention period when participant i was in the why condition or the how condition, respectively. Therefore, β_2 and β_3 indicate the change in water use from the baseline to the intervention period for the two experimental conditions. Similarly, W_2 and H_2 are set to 0 in both the baseline and intervention period and are 1 in the last 30 days of the experiment (the post-intervention period) for the why and how condition, respectively. Therefore, β_4 and β_5 indicate the difference in water use from baseline to the post-intervention period. We also modeled the time trends for each intervention period per experimental condition, T_1 for the baseline period, T_2 for the intervention period, and T_3 for the post-intervention period. Therefore, β_6-β_{11} represent the time trends per condition in each specific intervention period. Finally, the error term (ε_{it}) represents the unexplained variance by this model.

As we hypothesized that biospheric values would interact with the construal level manipulations, we included biospheric values as a moderating variable in a second model; represented in equation 2. Equation 2 is essentially an extension of our first model, including the main effect of biospheric values (mean-centered) for individual i (Bio) and the interaction between biospheric values and the construal level manipulations. Therefore, β_{13} and β_{14} provide the direction of the interaction effect between biospheric values and the why and how condition, respectively, in terms of water use in the intervention period compared to the baseline period. Similarly, β_{15} and β_{16} show the same interaction effect but this time for the effect on water use in the post-intervention period as compared to the baseline period.

$$(2)\quad y_{it} = \alpha_i + \beta_1 CLT + \beta_2 W_{1it} + \beta_3 H_{1it} + \beta_4 W_{2it} + \beta_5 H_{2it} + \beta_6 W_i T_{1it} + \beta_7 W_i T_{2it} + \beta_8 W_i T_{3it} + \beta_9 H_i T_{1it} + \beta_{10} H_i T_{2it} + \beta_{11} H_i T_{3it} + \beta_{12} Bio_i + \beta_{13} Bio_i W_{1it} + \beta_{14} Bio_i H_{1it} + \beta_{15} Bio_i W_{2it} + \beta_{16} Bio_i H_{2it} + \varepsilon_{it}$$

Table 2 presents the results from all regression analyses, including the same analyses on electricity use in terms of socket and light use. In terms of water use reduction while participants received real-time feedback, the results indicated that all

participants significantly reduced their water use (−17% on average). Opposed to our expectation that the low construal level condition ("how") would be more effective, we did not find significant differences between the construal level conditions ($\chi^2(1) = 0.003$, $p = .958$). In the post-intervention period, all participants increased their water use as compared to the intervention period (+8%; see Appendix 1, no significant differences between conditions; $\chi^2(1) = 0.640$, $p = .424$), but still used significantly less (−10%) water than in the baseline period (regardless of condition, $\chi^2(1) = 0.555$, $p = .456$). The latter finding is also opposed to our hypothesis that the high construal level manipulation would result in more long-lasting effects, as our results indicate that participants in both construal level conditions used less water in the post-intervention period. The average daily water use for the entire study period is depicted in Figure 1.

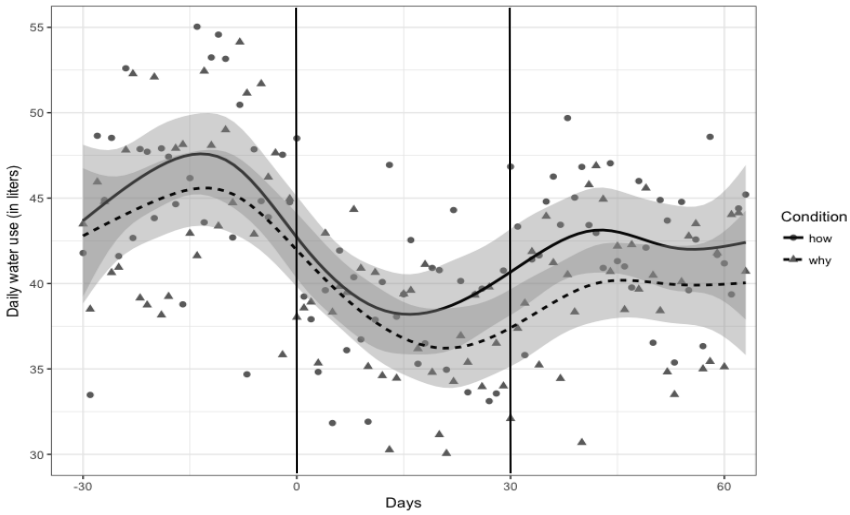


Figure 1 Daily warm water use per condition throughout the three-month study period. The line represents a smoothed line for ease of presentation, computed by the *R*'s generalized additive models (GAM) option. The first vertical line represents the time of installation of the real-time feedback device (Day 0) and the second vertical line represents the time of removal of the real-time feedback device (Day 30).

Table 2 Full model with baseline period as reference category

	Water Use (Liters)		Electricity Use (Sockets; Watt Hour)		Electricity Use (Light; Watt Hour)	
	(1)	(2)	(1)	(2)	(1)	(2)
Constant	44.80 (2.57)***	44.73 (2.59)***	245.32 (20.75)***	245.16 (20.59)***	338.29 (28.74)***	338.34 (28.03)***
Condition	−1.25 (3.63)	−1.10 (3.66)	4.13 (29.37)	5.03 (29.14)	0.02 (40.77)	0.45 (39.78)
Why During	−7.69 (1.10)***	−7.81 (1.10)***	−21.74 (5.65)***	−22.73 (5.65)***	−27.04 (8.35)**	−27.35 (8.36)**
How During	−7.60 (1.21)***	−7.54 (1.21)***	−5.98 (5.66)	−5.99 (5.65)	−33.86 (8.09)***	−34.21 (8.09)***
Why After	−2.69 (1.11)	−2.71 (1.11)*	−40.41 (6.39)***	−40.73 (6.38)***	−27.17 (8.70)**	−27.38 (8.70)**
How After	−3.88 (1.16)***	−3.81 (1.16)***	−19.28 (5.37)***	−19.46 (5.37)***	−64.59 (7.78)***	−64.89 (7.77)***
Biospheric		−0.17 (1.63)		12.74 (13.01)		−45.96 (17.71)*
Biospheric × Why During		−0.20 (1.06)		−5.76 (4.72)		2.38 (6.82)
Biospheric × How During		0.57 (0.77)		14.91 (3.98)***		5.40 (5.60)
Biospheric × Why Post		−2.97 (1.06)**		−18.14 (4.70)***		5.53 (6.88)
Biospheric × How Post		1.01 (0.77)		14.34 (4.07)***		16.34 (5.63)**
Time Pre × Why	0.01 (0.03)	0.01 (0.03)	−0.32 (0.13)*	−0.34 (0.14)*	0.20 (0.23)	0.19 (0.23)
Time Pre × How	−0.02 (0.03)	−0.02 (0.03)	0.27 (0.13)*	0.32 (0.13)*	−0.01 (0.18)	−0.02 (0.18)
Time During × Why	0.03 (0.03)	0.03 (0.03)	−0.20 (0.12)	−0.17 (0.13)	0.41 (0.18)*	0.41 (0.18)*
Time During × How	−0.004 (0.03)	−0.004 (0.03)	−0.01 (0.14)	0.01 (0.14)	0.34 (0.21)	0.36 (0.21)
Time Post × Why	−0.06 (0.03)*	−0.06 (0.03)*	−0.08 (0.14)	−0.10 (0.14)	−0.29 (0.19)	−0.30 (0.19)
Time Post × How	−0.04 (0.03)	−0.04 (0.03)	0.20 (0.15)	0.27 (0.15)	0.74 (0.21)***	0.76 (0.21)***
Observations	5,632	5,632	8,334	8,334	8,544	8,544
Goodness-of-fit (Deviance)	50,502	50,490	104,488	104,453	113,626	113,611

Note. Treatment effects in liters (water use) and watt hour (electricity use) with standard errors in parentheses *** $p < .001$, ** $p < .01$, * $p < .05$

Next to the actual water use, the feedback device itself recorded the number of showers during the feedback period. Performing a linear regression analysis, in which we included condition as the independent variable, did not result in significant differences between the two construal level conditions in terms of how often participants showered (β = 3.22, $t(88)$ = 0.94, p = .348). Moreover, we asked participants in both the pre- and post-intervention survey about their shower behavior and performed a repeated measures analysis of variance, in which we included the effect of time (i.e., from pre to post), the construal level condition, and the interaction between time and construal level. For self-reported shower behavior, participants indicated that they significantly improved on their shower behavior ($F(1,90)$ = 11.46, p = .001). Moreover, condition significantly interacted with time ($F(1,90)$ = 5.85, p = .018), which indicated that participants in the low construal level condition improved more on their shower behavior than participants in the high construal level condition. In terms of self-reported shower habit, all participants thought more consciously about their shower duration ($F(1,90)$ = 14.53, $p < .001$), but we did not find a significant interaction between condition and time ($F(1,90)$ = 0.04, p = .852).

Moderating effect of biospheric values. We hypothesized that biospheric values would be related to baseline water use. Specifically, we expected that participants who scored higher on biospheric values, would use less water in the baseline period. However, we did not find a significant relation between biospheric values and objectively measured baseline water use (β = 0.32, $t(90)$ = 0.18, p = .860), nor with self-reported shower behavior (β = 0.10, $t(90)$ = 0.94, p = .352). Besides the relation between biospheric values and baseline water use, we were interested in the potential moderating effects of biospheric values.

Table 2 also shows the results from our second model in which biospheric values are included as moderating variable. Our results indicated that biospheric values did not moderate the relation between the construal level manipulations and water use from baseline to the feedback period. We did find a significant interaction between the high construal level condition ("Why") and biospheric values on water use in the post-intervention period as compared to both the baseline and feedback period. Specifically, participants who scored higher on biospheric values reduced their water use significantly more in the post-intervention period as compared to those who scored lower on biospheric values (see Table 2) and those in the low construal level condition (compared to baseline period: $\chi^2(1)$ = 9.39, p = .002; compared to feedback period: $\chi^2(1)$ = 4.97, p = .026).

Spillover behavior. We also measured the electricity use throughout the three-month study period. We performed the same multilevel modeling approach to analyze the effect of the construal level manipulations on electricity use (divided between light and socket use). The results are presented in Table 2 with the baseline period as the reference period and in Appendix 1 for the results with the intervention period as reference period.

Socket use. For socket use, we found an overall downward trend throughout the three-month period. When we specifically look at the socket use between the two conditions, we found several significant differences. Participants in the high construal level ("Why") condition significantly reduced their socket use from the baseline period to the intervention period. Moreover, the reduction in socket use was significantly greater than the reduction in socket use for those in the low construal level ("How") condition ($\chi^2(1) = 3.88$, $p = .049$). The average daily socket use is depicted in Figure 2.

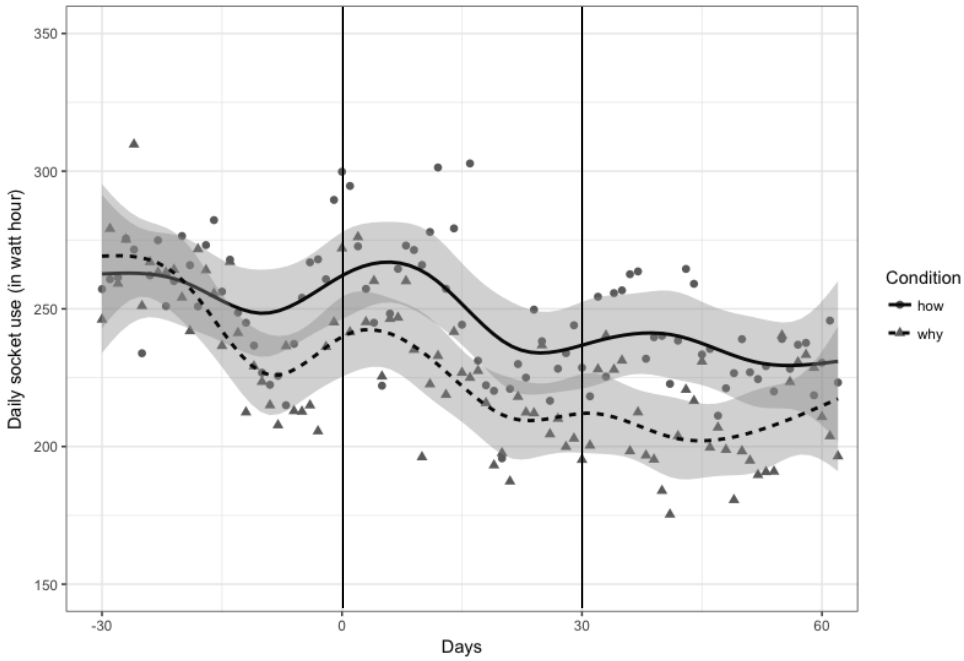


Figure 2 Daily socket use per condition throughout the three-month study period. The line represents a smoothed line for ease of presentation, computed by the *R*'s generalized additive models (GAM) option. The first vertical line represents the time of installation of the real-time feedback device (Day 0) and the second vertical line represents the time of removal of the real-time feedback device (Day 30).

Similarly, in terms of socket use in the post-intervention period as compared to the baseline period, participants in the high construal level condition used significantly less electricity for their sockets than participants in the low construal level condition ($\chi^2(1) = 6.42$, $p = .011$). As compared to the intervention period, the change in socket use to the post-intervention period did not significantly differ between the two conditions ($\chi^2(1) = 0.44$, $p = .508$).

Similar to water use, we also explored the potential moderating effect of biospheric values on the effect of the construal level conditions on socket use. Accordingly, we also first checked whether biospheric values were related to baseline socket use, which was not significant ($\beta = 13.07$, $t(90) = 0.92$, $p = .361$). Compared to socket use in the baseline period, biospheric values moderated the effect of the construal level manipulations on socket use in the feedback period and the post-intervention period. The interaction between the how condition and biospheric values significantly differed from the interaction between the why condition and biospheric values in the intervention period ($\chi^2(1) = 11.30$, $p < .001$) as well as in the post-intervention period ($\chi^2(1) = 27.49$, $p < .001$). This interaction indicated that those scoring higher on biospheric values, reduced their socket use in the (post-)intervention period when they were in the why condition, but actually increased their socket use in both the intervention and post-intervention period when they were in the how condition.

Light use. In terms of light use, we also observe a general downward trend for both conditions over time (see Figure 3). Compared to baseline light use, participants in both the how and why condition significantly reduced their light use in the intervention period and we did not find a significant difference between the two conditions ($\chi^2(1) = 0.34$, $p = .558$).

Again, compared to baseline use, we found a significant reduction in light use for both the how and why condition in the post-intervention period, but also found a significant difference between the two conditions ($\chi^2(1) = 10.29$, $p = .001$). This significant difference indicated that participants in the how condition reduced their light use significantly more than those in the why condition, which is contrary to socket use and our hypothesis that the high construal level manipulation would lead to positive spillover. Moreover, when we compare the light use in the intervention period to the light use in the post-intervention period, we only found a significant reduction in light use for the how condition, which significantly differs from the why condition ($\chi^2(1) = 7.26$, $p = .007$).

Additionally, we looked at the potential moderating effect of biospheric values on the relation between the two conditions and light use. Again, we first looked at the associated between baseline light use and biospheric values and found that those who scored higher on biospheric values in the baseline period used their lights less (β = −46.14, $t(90)$ =−2.47, p = .016). Our results also indicated that biospheric values had a main effect on light use throughout all periods, indicating that those who scored higher on biospheric values used less electricity to operate their lights. Moreover, when we compared the light use in the baseline period with light use in the post-intervention period, we found a significant interaction between biospheric values and the how condition. This interaction indicated that those who scored higher on biospheric values used significantly more light in the post-intervention period when they were in the how condition, but this did not significantly differ from the interaction between the why condition and biospheric values ($\chi^2(1) = 1.49$, p = .223).

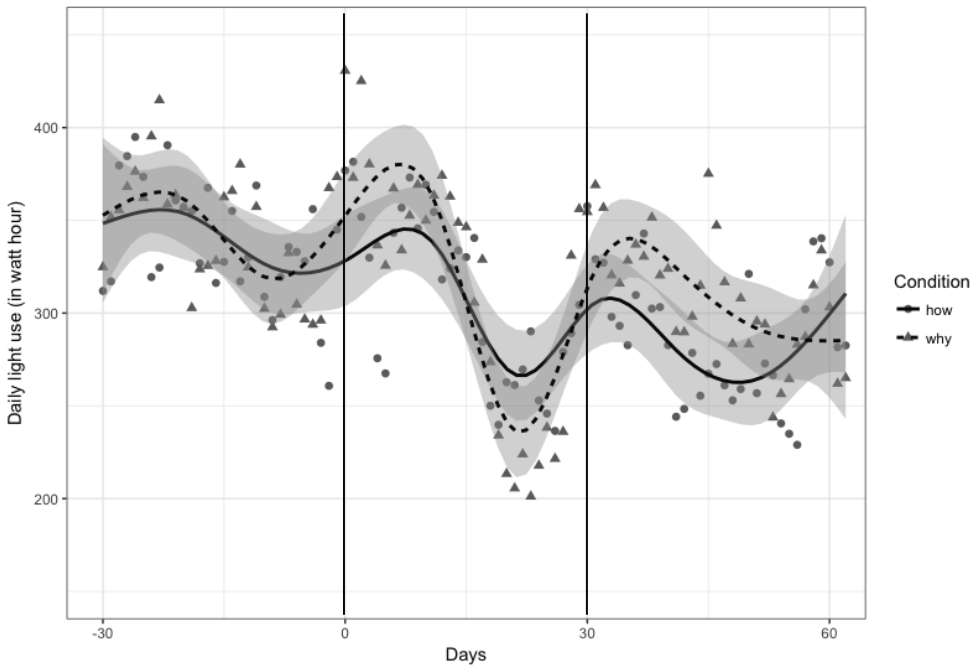


Figure 3 Daily light use per condition throughout the three-month study period. The line represents a smoothed line for ease of presentation, computed by the *R*'s generalized additive models (GAM) option. The first vertical line represents the time of installation of the real-time feedback device (Day 0) and the second vertical line represents the time of removal of the real-time feedback device (Day 30).

Self-report measures. We also asked participants a number of questions on their electricity use in the pre- and post-survey and performed a repeated measures analysis. Participants, however, indicated that they did not improve on their electricity use behavior ($F(1,90) = 0.10$, $p = .752$), nor did condition have a significant effect ($F(1,90) = 0.001$, $p = .977$).

5.3.2 Exploratory analyses

Gender effects. Even though we did not construct a specific hypothesis for gender effects on baseline water use and change in water use throughout the experiment, we were interested in exploring the potential moderating effect of gender. Similar to biospheric values, we included gender as a moderating function in the model (0 = male, 1 = female). As can be seen in Figure 4, male participants used significantly less water in the baseline period.

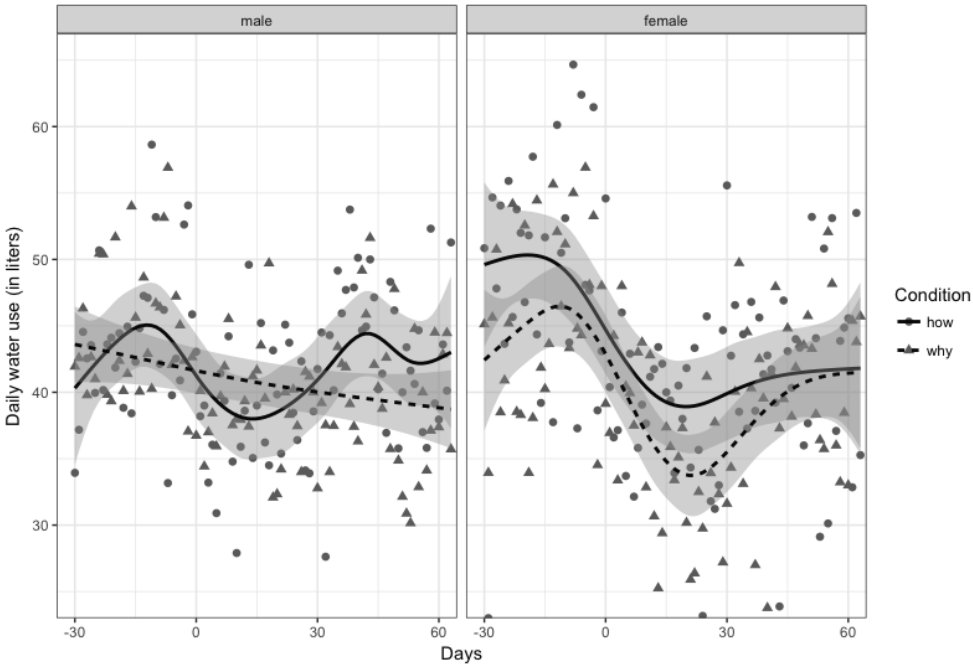


Figure 4 Daily water use per condition and gender throughout the three-month study period. The line represents a smoothed line for ease of presentation, computed by the *R*'s generalized additive models (GAM) option.

All results from the regression for the moderating function of gender effects are depicted in Appendix 2. Our regression analysis shows that female participants used

significantly more water in the baseline period and female participants reduced their water use significantly more. The reduction in water use among male participants was smaller, which was in part due to the baseline differences in water use. Moreover, the why condition had the most lasting effects on reduced water use among male participants, whereas the how and why condition were equally effective in terms of water use in the post-intervention period for female participants.

Self-report measures. In the survey we included a number of questions on the sustainability of the student housing facility, as well as questions on how well the device functioned. In terms of the perceived sustainability efforts of the student housing facility, we found that participants indicated that they thought the student housing facility was actually acting in a more sustainable manner at the end of the experiment as compared to the beginning ($F(1,90) = 5.17$, $p = .025$; see Table 1). It did not matter, however, whether participants were in the low or high construal level condition ($F(1,90) = 0.002$, $p = .967$). We also asked participants a number of questions on the real-time feedback device in the post-survey and performed a linear regression analysis in order to detect differences between the two construal level conditions. We did not find a significant difference between the conditions in terms of the ease of reading the information on the device ($\beta = 0.16$, $t(91) = 1.52$, $p = .132$), noticing the device ($\beta = 0.02$, $t(91) = 0.18$, $p = .859$), how much they liked the information on the device ($\beta = 0.02$, $t(91) = 0.23$, $p = .821$) and how guilty they felt due to the information on the device ($\beta = -0.11$, $t(91) = -1.08$, $p = .285$). Finally, we asked participants whether they set a goal during the time that the real-time feedback device was in place and did not find significant differences between the two conditions ($\beta = -0.08$, $t(91) = 0.72$, $p = .476$).

5.4 Discussion

5.4.1 Implications of findings

Before starting data collection of this research, we constructed a number of hypotheses and submitted these hypotheses to aspredicted.org. Our first hypothesis concerned the effectiveness of real-time feedback and our results indicate, in line with previous findings, that real-time feedback led to a 17% decrease in water use. The decrease in water use was slightly lower than the findings from Tiefenbeck et al. (2016), who found a decrease of approximately 20%, which we ascribe to the different set-up of our study. As such, in our study, the installation of the device was done for participants, and participants did not actively sign up for a study focused on reducing water use. The findings from our study thus add to previous research on real-time

feedback by showing that also when someone else installs the device and people do not have to put effort in getting the device can be almost equally effective.

Besides the direct effect of real-time feedback on water use, we were particularly interested in the effects of the construal level manipulations on water use while receiving feedback, but also on water use after participants did not receive feedback any longer (Hypothesis 2). As such, we were particularly interested in whether people could form a new habit after receiving real-time feedback for one month. We expected that the low construal level manipulation would lead to the greatest reduction in water use while participants were receiving feedback, but that these participants were also the most likely to return to their initial level of water use after the feedback device had been removed. Our findings did not support this hypothesis, as participants in the low construal level condition did not significantly differ from those who were in the high construal level condition for both the real-time feedback period and the post-intervention period. Moreover, we expected that participants in the high construal level condition would develop a stronger habit to take shorter showers, also when the real-time feedback device was removed, whereas we did not anticipate such lasting effects for the low construal level condition. Our results indicate that in both construal level conditions, participants used significantly less water in the post-intervention period as compared to the baseline period (−10%). Compared to the feedback period, all participants started using more water again (+8%), but they did not relapse to their initial water use level, suggesting that all participants have created a shorter shower habit. This finding shows that a one-month period of receiving real-time feedback can be enough to change habits, which is in line with previous research on changing transportation habits (Fujii & Kitamura, 2003; Thøgersen & Møller, 2008). Whether participants' shower behavior has become a true habit remains to be studied; as such, we were unable to assess at the end of the three-month period whether people actively thought about the duration of their shower or whether it was something automatic and habitual.

Our third hypothesis considered the moderating effect of biospheric values. Before we analyzed the potential moderating effect, we first checked whether biospheric values correlated with baseline water use. Surprisingly, our results indicated that biospheric values were not necessarily indicative of water use in the baseline period or of self-reported shower behavior. This is in contrast to previous research, which has highlighted that biospheric values are a strong predictor of pro-environmental behavior (e.g., de Groot & Steg, 2008). It is, however, in line with work that suggests that the correlation between psychological factors such as values and energy use behavior tends to be typically rather low (Frederiks et al., 2015b).

Nonetheless, when we look at the effectiveness of our manipulations, we found that the high construal level manipulation was especially effective among participants who scored higher on biospheric values. This is in contrast to our hypothesis, as we expected that participants who scored lower on biospheric values would use more water in the baseline period and would thus have more "room for improvement." However, as participants who scored higher on biospheric values did not use less water in the baseline period, which suggests that those who value the environment also still have room for improvement and are able to reduce their water use. Nevertheless, the fact that people who scored higher on biospheric values acted more upon those values when they were in the high construal level condition is in line with construal level theory, as previous findings suggest that people act more upon their values when they think at a high construal level (Giacomantonio et al., 2010). Moreover, other research on pro-environmental behavior has also shown that reminders of the importance of pro-environmental behavior (which could have been induced by our high construal level manipulation) reminds people of their environmental values and are thus more likely to act upon them (Bolderdijk, Gorsira, et al., 2013).

In terms of net environmental impact (Hypothesis 4), we looked at potential spillover to electricity use in the rooms. Across both construal level conditions, we found evidence for positive spillover to electricity use. We found that the low construal level condition turned out to be especially helpful for reducing light use; whereas the why condition was more effective in reducing socket use. We anticipated that only the high construal level condition would lead to positive spillover behavior. The fact that we found that the low construal level condition led to more positive spillover to light use than the high construal level condition was surprising. However, it could be that the difficulty of the behavior may play an important role in whether spillover occurs to easier behaviors or more effortful behaviors. Switching the light off is a relatively easy behavior change, whereas reducing socket use requires more effort, as one actively has to completely switch off or unplug devices when no longer in use. As such, we expect that the high construal level manipulation can motivate more effortful behavior, whereas the low construal approach can facilitate easy behavior changes. We also explored the potentially moderating function of biospheric values on spillover behavior. In line with our findings for water use, we find that participants who scored higher on biospheric values in the high construal level condition reduced their socket use more in the post-intervention period as compared to the baseline period. This finding suggests that the high construal level condition makes people act more upon their inner values and enables people to see similarities between different types of energy-use behaviors.

Finally, we performed some exploratory analyses and were interested in potential gender effects. We saw that gender did play a significant role in baseline water use, as female participants were more likely to use more water in the baseline period as compared to their male counterparts. The intervention seemed to be more effective for women, as there was a greater decrease in water use. This is somewhat in line with previous research, which has suggested that women tend to behave more environmentally friendly than men (Kollmuss & Agyeman, 2002; Zelezny, Chua, & Aldrich, 2000). Yet, other studies did not find any significant differences between men and women (see Frederiks, Stenner, & Hobman, 2015). Moreover, our result can also be explained the fact that women used more water in the baseline period and thus actually had more room for improvement.

All in all, our results indicate that real-time feedback has long-lasting effects on shower behavior, even after the feedback device is removed. In terms of the long-lasting effect of receiving real-time feedback in combination with a construal level manipulation, we see that it is most effective among participants who value the environment highly and thought about their water use at a high construal level. Even though this is in line with previous work (e.g., Giacomantonio et al., 2010), this study is the first to show that a rather subtle construal level manipulation administered to participants at the beginning of an intervention in the field can have long-lasting effects. Moreover, this suggests that construal level is important when people form new habits while taking individual environmental values into account, as it may ultimately determine what situational cue people attach to the automatic behavioral response.

5.4.2 Limitations and future research

The unique setting in which we were able to conduct this study enabled linking individual characteristics to individual energy use data, which is otherwise often done at the household level and has given us the opportunity to study individual difference factors. At the same time, a clear limitation of our set-up is that participants were clearly aware of being monitored during the experimental phase, which could have influenced our results to some extent (i.e., Hawthorne Effect; Mccambridge, Witton, & Elbourne, 2014). As such, it could be that participants simply started using less water or electricity due to the fact that they were aware of being monitored. Previous research on real-time feedback has provided some evidence for this monitoring effect, by showing that people in a control condition also start using slightly more water over time; this suggests that the installation of a feedback device may have resulted in an initial drop in water use, but that over time participants return to their normal shower

behavior (Tiefenbeck et al., 2016). This finding also implies that people pay less attention to the monitoring issue over time. As such, the first few days it may be very salient to participants that they are being monitored, but after a short period of time this may not affect their behavior any longer. This is in line with previous research on how much attention people pay to energy monitors (Webb et al., 2014); after one week people paid far less attention to an energy monitor, which could be similar in our study, at least to the extent that people are not actively thinking about being monitored. Moreover, as all participants were aware of being monitored, and we were mostly interested in the differences between conditions, we suppose that people's awareness of being monitored did not affect those differences.

Another concern with research on pro-environmental behavior and more specifically on energy conservation behavior, is that a lot of studies suffer from self-selection problems. In our study, we tried to minimize self-selection issues as much as we could. Specifically, we did not communicate the intervention as a clear energy conservation study, nor did we explicitly urge people to reduce their energy consumption. The experiment was simply designed to let people think for themselves about their water use (either at a high construal level or a low construal level) and provided them with a feedback device. The effort individuals had to put in participating in this research was simply being at home and the willingness to fill out a 10-minute survey twice. We deem that this set-up has enabled us to get a diverse group of individuals, with some caring more about the environment and their environmental impact than others. Moreover, as we were constrained by the rooms that actually were outfitted with measurement equipment, we only approached students staying in those rooms. If all rooms had been outfitted with measurement equipment, it would have been far easier to find our intended number of participants, but this would have most likely suffered from more self-selection problems. We consider that this is an important feature of our study, as it enabled us to reach and study a group of participants that may otherwise not participate.

Additionally, people who usually do sign up for energy saving campaigns, care more about the environment than the average population. As previous research suggests that people who value the environment show more pro-environmental behavior (de Groot & Steg, 2008), these individuals may not be able to improve their behavior much more and people who care less about the environment might be a more interesting target group. However, our results did not show a strong relation between environmental values and baseline energy use. The important take away from this research is that people will only act upon their biospheric values when they think of their behavior at a high construal level.

Due to the design and constraints of the number of people that could participate in this research, we did not include a pure control condition. Future research should also include a control condition to study how other time trends affect water and energy use, that cannot be accounted for by the experimental manipulations. Even though we acknowledge this shortcoming of our design, having a month of baseline data for water and energy use has given us the opportunity to objectively detect the differences in water use within individuals and between the experimental manipulations.

Finally, we reason that construal level theory can add to our current understanding of the effectiveness of different intervention approaches. As our results indicate that when people think at a high construal level they are more likely to act upon their biospheric values. Therefore, when interventions target pro-environmental behavior, it is important to consider the target group (how much do they value the environment) and the desired long-term effects of the intervention (is it a one-off decision or repeated behavior). Future research is needed to study how construal level manipulations work in different types of situations; for example, do interventions work the same at home as they do at a hotel? Does it matter whether one-off decisions are the unit of observation or habitual day-to-day actions? Likewise, in the current study we have chosen for a one-month period of providing participants with real-time feedback; future studies can study how long it actually takes for people to effectively change their shower behavior. Our results show that receiving real-time feedback for one month has led to a reduction in water use, also when people do not receive feedback any longer, but future studies should also study how often people have to receive this information to accomplish the same result.

5.4.3 Concluding remarks

In conclusion, the current study has successfully replicated previous findings on the effectiveness of real-time feedback on shower behavior. More importantly, our study provides more insight in the thought process that is involved when starting a new behavior: the construal level at which people think about the behavior. Due to the unique setting of the current study, we were able to link objective measures of energy use data to psychological individual difference variables, which enabled us to provide a more nuanced view on how interventions work out in terms of objectively measured energy use behavior. Our results indicate that both low and high construal level thinking facilitate a reduction in water use, but that high construal level thinking is most effective among individuals who value the environment for long-lasting behavior change.

5.5 Appendices

Appendix 1. Full model with intervention period as reference category
Appendix 2. Moderating effect of gender on water use
Appendix 3. Self-report measures per condition

Appendix 1. Full model with intervention period as reference category

Table A1.1 *Full model with intervention period as reference category*

	Water Use (Liters)		Electricity Use (Sockets; Watt Hour)		Electricity Use (Light; Watt Hour)	
	(1)	(2)	(1)	(2)	(1)	(2)
Constant	37.20 (2.57)	37.19 (2.58)***	239.34 (20.78)***	239.01 (20.68)***	304.42 (28.84)***	304.20 (28.05)***
Condition	−1.24 (3.63)	−1.35 (3.64)	−11.63 (29.35)	−11.37 (29.20)	6.84 (40.71)	7.27 (39.60)
Why Pre	7.69 (1.10)***	7.82 (1.10)***	21.74 (5.65)***	22.78 (5.65)***	27.04 (8.35)**	27.17 (8.36)**
How Pre	7.60 (1.21)***	7.53 (1.21)***	5.98 (5.66)	5.96 (5.65)	33.86 (8.09)***	34.15 (8.09)***
Why After	5.00 (1.09)***	5.08 (1.09)***	−18.67 (6.07)**	−17.96 (6.07)**	−0.12 (8.08)	−0.08 (8.08)
How After	3.72 (1.17)**	3.73 (1.17)**	−13.29 (5.40)*	−13.49 (5.41)*	−30.72 (7.98)***	−30.75 (7.98)***
Biospheric		0.08 (1.62)		19.30 (13.04)		−41.78 (17.65)*
Biospheric × Why Pre		0.69 (1.06)		5.50 (4.72)		0.10 (6.82)
Biospheric × How Pre		−0.83 (0.77)		−14.73 (3.98)***		−7.06 (5.60)
Biospheric × Why Post		−2.55 (1.06)*		−12.67 (4.68)**		4.30 (6.76)
Biospheric × How Post		0.33 (0.76)		−0.37 (4.02)		10.16 (5.56)
Time Pre × Why	0.01 (0.02)	0.002 (0.03)	−0.32 (0.14)*	−0.34 (0.14)**	0.20 (0.22)	0.19 (0.23)
Time Pre × How	−0.02 (0.03)	−0.02 (0.03)	0.27 (0.13)*	0.32 (0.13)**	−0.01 (0.18)	−0.02 (0.18)
Time During × Why	0.03 (0.03)	0.03 (0.03)	−0.20 (0.13)	−0.17 (0.13)	0.41 (0.17)*	0.41 (0.18)*
Time During × How	−0.005 (0.03)	−0.003 (0.03)	−0.01 (0.14)	0.01 (0.14)	0.34 (0.21)	0.35 (0.21)
Time Post × Why	−0.06 (0.03)*	−0.04 (0.03)*	−0.08 (0.14)	−0.10 (0.14)	−0.29 (0.19)	−0.30 (0.19)
Time Post × How	−0.04 (0.03)	−0.02 (0.03)	0.20 (0.15)	0.27 (0.15)	0.74 (0.21)***	0.76 (0.21)***
Observations	5,632	5,632	8,334	8,334	8,544	8,544
Goodness-of-fit (Deviance)	50,502	50,489	104,488	104,453	113,626	113,611

Note. Treatment effects in liters (water use) and watt hour (electricity use) with standard errors in parentheses;
*** $p < .001$, ** $p < .01$, * $p < .05$

Appendix 2. Moderating effect of gender on water use

Table A2.1 *Full model for gender effects on water use with baseline as reference period (left) and intervention as reference period (right)*

	Baseline Period Water Use (Liters)		Intervention Period Water Use (Liters)	
	(1)	(2)	(1)	(2)
Constant	44.80 (2.57)***	43.42 (3.13)	37.20 (2.57)	37.73 (3.12)***
Condition	−1.25 (3.63)	−1.86 (3.65)	−1.24 (3.63)	−1.10 (3.64)
Why Pre	−7.69 (1.10)***	−5.56 (1.48)***	7.69 (1.10)***	5.76 (1.48)***
How Pre	−7.60 (1.21)***	−5.14 (1.45)***	7.60 (1.21)***	4.97 (1.45)***
Why After	−2.69 (1.11)*	−1.56 (1.43)	5.00 (1.09)***	4.08 (1.45)**
How After	−3.88 (1.16)***	−0.97 (1.36)	3.72 (1.17)**	4.10 (1.39)**
Gender		3.84 (3.60)		−1.43 (3.59)
Gender × Why Pre		−4.13 (1.91)*		3.75 (1.91)
Gender × How Pre		−6.36 (2.00)**		6.78 (2.00)***
Gender × Why During		−2.29 (1.90)		
Gender × How During		−8.04 (2.00)***		
Gender × Why Post				1.70 (1.89)
Gender × How Post				−1.52 (2.00)
Time Pre × Why	0.01 (0.03)	0.01 (0.03)	0.01 (0.02)	0.01 (0.03)
Time Pre × How	−0.02 (0.03)	−0.03 (0.03)	−0.02 (0.03)	−0.04 (0.03)
Time During × Why	0.03 (0.03)	0.02 (0.03)	0.03 (0.03)	0.02 (0.03)
Time During × How	−0.004 (0.03)	−0.01 (0.03)	−0.005 (0.03)	−0.01 (0.03)
Time Post × Why	−0.06 (0.03)*	−0.06 (0.03)*	−0.06 (0.03)*	−0.06 (0.03)*
Time Post × How	−0.04 (0.03)	−0.02 (0.03)	−0.04 (0.03)	−0.02 (0.03)
Observations	5,632	5,632	5,632	5,632
Goodness-of-fit (Deviance)	50,502	50,479	50,502	50,478

Note. Treatment effects in liters with standard errors in parentheses. Gender is scored as 0 = male, 1 = female. *** $p < .0001$, ** $p < .01$, * $p < .05$

Appendix 3. Self-report measures per condition

Table A3.1 *Means (standard deviations) of self-report measures pre- and post-survey per condition*

	Pre-intervention survey		Post-intervention survey	
Self-report measures	*How*	*Why*	*How*	*Why*
Trait construal level	0.55 (0.23)	0.57 (0.24)	0.56 (0.22)	0.63 (0.23)
Perceived sustainability	4.14 (1.35)	4.62 (1.18)	4.35 (1.41)	4.82 (1.21)
Energy conservation behavior				
Shower	2.95 (1.07)	3.03 (1.19)	3.51 (1.25)	3.13 (1.26)
Electricity	4.59 (1.19)	4.30 (1.14)	4.62 (1.37)	4.35 (1.14)
Shower habit	3.91 (1.92)	3.65 (1.66)	4.54 (1.56)	4.35 (1.42)
Values				
Hedonic	7.28 (1.27)	7.66 (1.02)	7.08 (1.29)	7.54 (0.96)
Egoistic	5.92 (1.05)	6.21 (1.06)	5.87 (1.10)	6.12 (0.89)
Altruistic	7.48 (1.02)	7.93 (0.79)	7.48 (0.99)	7.62 (0.95)
Biospheric	7.45 (1.23)	7.45 (1.01)	7.30 (1.12)	7.32 (1.03)

Chapter 6

General discussion

6.1 Introduction

Reductions in individual energy use are much needed to reduce human impact on the environment. Although much of previous research has focused on residential energy use, people spend a great portion of their day outside their home (e.g., on holidays, at work). These situations are fundamentally different in at least one way: people do not financially benefit directly from reducing their energy use. It is, therefore, of importance to understand how energy saving behavior can be triggered across such situations. Even though much research has focused on household energy use, we have taken the general findings from this domain with regards to interventions and inferred that it is crucial to systematically test (combinations of) interventions while using one general framework (see Abrahamse, Steg, Vlek, & Rothengatter, 2005; Frederiks, Stenner, Hobman, & Fischle, 2016). In the general introduction, we considered it to be important to appropriately incorporate three factors within the framework of our choice: the net impact of interventions, the functioning of combined intervention approaches and the influence of (biospheric) values. After considering different models, we decided to apply construal level theory as a general framework, as we reasoned that this theory is able to capture all three aspects we wanted to study.

Construal level theory poses that people process information at either a low construal level, which is more concrete and immediate, or at a high construal level, which is rather abstract and distant (Liberman & Trope, 1998; Trope & Liberman, 2003). Ultimately, reducing individual energy use is a way to reduce our impact on the environment. To spark behavior change, some have argued in favor of low construal level approaches, whereas others have argued the opposite. As such, on the one hand, some researchers have suggested to make environmental problems more personally relevant (i.e., represented at a low construal level), which may increase a sense of urgency and thereby motivate people to act accordingly (e.g., van der Linden, Maibach, & Leiserowitz, 2015). On the other hand, and in direct contrast to this, others have argued in favor of high construal level approaches, as people may be more inclined to act upon their values, which can ultimately enable long-term change (Fujita et al., 2013). Despite this apparent contradiction, we argued that both lines of reasoning may be true, but that the effectiveness of high and low construal level approaches depends on the type of behavior change that is targeted. Specifically, we expected that the effectiveness of construal level interventions depends on whether it targets (1) short-term change, (2) long-term change, or (3) spillover behavior. We evaluated the effectiveness of our interventions across different settings (i.e., hotel, student housing, laboratory setting, online), targeted at different behaviors (i.e.,

electricity and water use), and using different construal level manipulations (i.e., social distance and how versus why task).

In this chapter, we will first summarize the findings and discuss the theoretical implications. Next, we will discuss some methodological issues regarding how we have measured energy use behavior. Thereafter, we will describe the limitations of this work and discuss some avenues for future research. This is followed by a discussion of the practical implications, in which we provide some concrete suggestions for designing interventions targeted at energy use for policy makers and researchers. We will close this chapter by providing our final conclusions.

6.2 Summary and theoretical implications

Across four chapters we were interested in the effectiveness of our interventions both in the short-run and in the long-run, and in the potential spillover to other energy-related activities. We argued that both low and high construal level manipulations would be effective in realizing short-term change. More specifically, we expected that low construal level manipulations would be more effective in the short run as compared to high construal level approaches. In terms of the long-term effects of the interventions, we expected that especially high construal level manipulations would be effective, and that the positive short-term effectiveness of low construal interventions would dissipate over time. As we argued that it is not only important to look at the effectiveness of interventions in terms of the change in a target behavior, but also look at the effects on related energy-use behaviors, we were also interested in potential positive and negative spillover effects. We specifically argued that high construal level interventions would most likely lead to positive spillover, whereas we expected that low construal level interventions would lead to either negative or no spillover behavior. Across all types of behaviors, we studied the potentially moderating effects of biospheric values.

In several studies we studied the short-term effect of our manipulations either due to practical concerns (laboratory setting; Chapter 2) or as it mimicked the real-life situation (hotel setting; Chapter 3). In the studies we ran at The Student Hotel with a student sample, we obtained data to assess longer-term effects, either in terms of weeks (Chapter 4) or months (Chapter 5). In addition to the objective measures of energy use, across all studies participants were also asked for self-reported water and energy use behavior, which allowed us to compare self-reports and objective measures with one another. Additionally, in the field experiments at The Student Hotel we were able to also measure electricity use, while our interventions targeted water use, which allowed us to assess potential spillover effects. In Table 1, we have summarized the

operationalizations of the construal level manipulations across the different chapters. For each study we indicate what we have manipulated, the effectiveness of combinations, the role of values and the overall net impact of the manipulations. We will subsequently discuss these findings in more detail in terms of short-term effects, long-term effects and observed spillover behavior.

6.2.1 Short-term effects

The first aim of this dissertation was to understand the short-term effectiveness of our manipulations, and across all of our studies we were able to detect these effects. We expected that low construal level approaches would be more effective in sparking short-term change as compared to high construal level approaches. In Chapter 3 we specifically targeted short-term behavior change, whereas in Chapter 4 and 5 we were able to measure both the short-term and long-term effects on behavior. In Chapter 2 we studied the short-term effect of an investment on curtailment behavior, which we consider a spillover behavior and the results will therefore be discussed in Section 6.2.3.

In Chapter 3 we specifically targeted short-term behavior change by focusing on shower behavior during the first night stay at a hotel. Across two studies, we found no significant differences between the experimental messages. However, when we take biospheric values into account, we do see differences between the conditions. First of all, participants who indicated to care about the environment were unaffected by any of the construal level messages. We speculate that this may be due to the fact that there is little room for improvement for this group of participants. Our results indicate that those who scored higher on biospheric values indicated to shower shorter at home and at a hotel on the self-report measures. Moreover, biospheric values were associated with water use among participants in the control condition, indicating that indeed those who scored higher on biospheric values used less water during their stay.

Table 1 *Summary table of methods and results empirical chapters*

	Construal level[1]	Operationalization	Setting	Target behavior	Combinations	Biospheric values	Net impact
Chapter 2							
	Low High	Investment self Financial Investment other Environmental	Laboratory experiment (1-hour session)	Switching lights off	High congruent combination most effective combinations	*NA*	High construal level message (i.e., environmental) most effective in stimulating curtailment behavior; especially when someone else invested
Chapter 3							
	Low High	Health Environment	Online survey and field experiment hotel (1 night)	Water use	Incongruent combination not more effective than single messages	Messages containing low construal level information effective among people who scored low on biospheric values	Messages containing low construal level information only positively affected water use, no impact on energy-related behaviors
Chapter 4							
	Low High	Gift to self How task Gift to other Why task	Field experiment student housing (6 weeks)	Water use	High congruent combination most effective	High congruent combination most effective among people who scored lower on biospheric values	High congruent combination most effective on target and spillover behavior
Chapter 5							
	Low High	How task Why task	Field experiment student housing (3 months)	Water use	*NA*	High construal level manipulation most effective among people who scored higher on biospheric values	High construal level highest net impact among people who scored higher on biospheric values

[1] In Chapter 2 we did not specifically operationalize the manipulations as construal level manipulations, but for this discussion we will also interpret the results from a construal level theory perspective.

Participants who scored lower on biospheric values were influenced by the low construal level messages, which is in line with our expectation that low construal level manipulations can effectively realize short-term behavior change. Specifically, participants who scored relatively low on biospheric values used less water when they received a message that focused on low construal level benefits of taking shorter showers either when the message was presented in isolation or in combination with the high construal level benefits. The fact that the combined message remained effective among this group of participants may seem to contrast earlier findings from Schwartz, Bruine de Bruin, Fischhoff, and Lave (2015), who showed that a combination of an environmental and financial (i.e., combination of a high and low construal level) message was less effective than a single environmental message. However, we argue that both findings are in line with construal level theory. Particularly, Fujita et al. (2013) argue that low construal level considerations are more direct and immediate and may thus be more influential in terms of how people behave. Therefore, in the combined message appeal, people may not notice the high construal level component any longer, as they only consider direct, immediate (low construal level) issues. In terms of our findings, this argument suggests that when the low construal level manipulation is effective by itself, a message that combines a low with a high construal level will be equally effective. The combined message is unlikely to be more effective than the single message as people do not process the high construal level information as such. Indeed, in terms of the findings by Schwartz et al. (2015), the high construal level (i.e., environmental benefits) component by itself was successful, whereas the low construal level (financial) message was not, and the combination was therefore not successful.

Most of the previous work did not contrast the combinations to single construal level manipulations (e.g., Chang et al., 2015; Goldsmith et al., 2016; White et al., 2011). In these combination studies, the authors show that congruent combinations (i.e., at the same construal level) are more effective than incongruent approaches. Our findings show that incongruent approaches are probably driven by the low construal level component. Moreover, we anticipate that incongruent approaches are actually equally effective as the single low construal level approach by itself. To systematically test different combinations of construal level manipulations, we tested both congruent and incongruent combinations in Chapter 4. In line with earlier work, we show that combinations that were at the same construal level were more effective, and the congruent combination at a high construal level proved to be most effective. This study is the first to show such effects in a field setting.

We hypothesized that congruent combinations would be most effective and the results from Chapter 4 indicate that a congruent combination at a high construal level resulted in the highest reduction in short-term water use (i.e., first week after the full intervention), as compared to the control group. We suggest that the congruent combination at a high construal level was especially effective because of the longer-term outlook of the situation participants were in. In other words, when people are staying at a hotel, they are likely to perceive this as a very short-term situation, whereas staying in a room for one year can be perceived as a rather long-term situation. We suggest that this also explains why we did not observe the anticipated effectiveness of the low construal level manipulation. Even though the low construal level combination also yielded a reduction in water use, this was not statistically different from the incongruent approaches. We argue that the way people perceive the situation may be an important factor as to whether the low or high construal level approach is most effective. As such, we argue that short-term situations (e.g., a 1-night stay at a hotel) are perceived differently from longer-term situations (e.g., a 1-year stay in a dormitory room), as the former corresponds to smaller temporal distance and the latter to larger temporal distance. From a construal level theory perspective, we expect that temporal distance influences the construal level at which people process the situation. Moreover, as we measured energy use in terms of weeks and were not specifically interested in the immediate energy use (e.g., one hour after participants received the intervention), we expect that the high construal level approach is more appropriate in longer-term situations. In other words, the high construal level combination was in line with the type of situation in which we targeted the behavior change.

Similar to Chapter 3, we found that biospheric values moderated the relation between the construal level manipulations and objectively measured behavior in Chapter 4. Again, we see that those who scored lower on biospheric values in the baseline period are more susceptible to change their behavior. Moreover, we found that the relation between biospheric values and objectively measured water use was higher in the post-intervention period, indicating that people actually act more upon their values after being exposed to the high construal level combination. Important to note here is that most participants scored relatively high on biospheric values, which also suggests that those who score relatively low on biospheric values are not totally unaware of their behavioral effects on the environment. Instead, they may not consider acting in an environmentally-friendly manner as their primary value in life and it is unlikely to guide their behavior in everyday life when they deem other values more important. Our results suggest that a congruent combination at a high construal

level can motivate these people to act more on their biospheric values and ultimately reduce their energy use.

Finally, in Chapter 5 we tested the effect of a construal level manipulation (the how versus why task; Freitas, Gollwitzer, & Trope, 2004) in combination with real-time feedback. As real-time feedback has been shown to have a strong effect on behavior, we were interested in studying whether construal level could influence how effective this real-time feedback would be in the short-term and long-term. In terms of objectively measured water use while participants were receiving real-time feedback, we found that participants in both the low and high construal level conditions reduced their water use significantly. This result shows that both types of manipulations can be effective in the short run, at least in the presence of real-time feedback. Interesting to note is that the effect was slightly different when we solely looked at the self-report measures. As such, the low construal level manipulation yielded better scores on self-reported shower behavior in the post-intervention survey as compared to the high construal level manipulation. This finding is in line with our expectations from a construal level theory perspective, as we expected that low construal level approaches would result in a larger reduction in water use during the feedback period. This suggests that some other processes may come into play when people are questioned about their behavior, and when objectively measuring their energy use; we will come back to this issue in Section 6.3, where we discuss the methodological implications of using different measures of energy use behavior.

In sum, our findings show that short-term behavior change can be sparked by both low and high construal level approaches. More specifically, two factors seem to be worthwhile to consider when designing interventions aimed at short-term behavior change: The type of situation and biospheric values. First of all, the type of situation influences how effective a low or high construal level intervention is. We argue that short-term situations, such as a hotel setting, fit a low construal level appeal better (Chapter 3). In contrast, when we assessed short-term behavior change in more stable settings (i.e., where people live for a longer period of time; Chapter 4 and 5), low construal level approaches may not be as effective. Instead, in such situations high construal level appeals may prove to be more effective, as it is more aligned with the situation. A second factor that we deem important is how much people value the environment. We found that biospheric values moderated the effectiveness of the construal level intervention approaches. In line with construal level theory, we see that short-term behavior change may be realized when focusing on low construal level benefits, which was the case in Chapter 3. This positive change is, however, reserved to those who do not highly value the environment. We speculate that the positive

change might have been instigated by the fact that people who do not highly value the environment value their health more and thus are more willing to act on the low construal-level information on health. In contrast, people who highly value the environment were not likely to change their behavior through simple manipulations such as a message when staying at a hotel. Our results suggest that this may be due to the fact that people who highly value the environment are more likely to use less water in the first place and therefore have less room for improvement. We did find that those who scored higher on biospheric values were more likely to take shorter showers at home and at a hotel. However, the association between biospheric values and water use tends to be stronger when self-report measures are used than when objective measures of water use are obtained. Similar to Chapter 3, we found that those who scored lower on biospheric values were more susceptible to change in Chapter 4. This seems to suggest that short-term behavior change can be realized among a group of people who would otherwise not act in a sustainable manner, as they do not highly value the environment. As such, it is likely that these individuals usually act on other values they may consider to be more important, but low construal level manipulations that are aligned with the short-term nature of the targeted situation can effectively spark short-term behavior change.

6.2.2 Long-term effects

The second aim of this research was to detect the long-term effects of construal level manipulations. Most of the previous work on construal level theory, but also on interventions targeted at energy use behavior, focuses on the immediate effects of an intervention (Abrahamse et al., 2005; Delmas et al., 2013). Yet, when studying energy use behavior, it is valuable to know whether the realized behavior change is lasting over a longer period of time and does not simply disappear after a short period. We expected that the high construal level manipulations and the congruent high construal level combinations would be effective in terms of realizing long-term behavior change. In Chapters 4 and 5 we were able to detect the longer-term effects of our construal level manipulations and we will elaborate on the implications of these findings below.

Our results provide evidence for the relative effectiveness of high construal level approaches, with the notion that biospheric values do play an important role in how effective the high construal level manipulations are. In Chapter 4, we were interested in the long-term effects of a combination of construal level manipulations. We were able to study the effectiveness of our interventions in terms of weeks; due to practical constraints we were unable to look beyond the specified intervention period (viz., participants moved out of their apartments). Although we found support for the high

construal level combination for short-term behavior change (i.e., the first week after participants received the full treatment), this effect disappeared after the first week. This result indicated that the effectiveness of our combined intervention approaches only had a short-lived effect, which we attribute to the subtlety of the construal level manipulations. The direct construal level manipulation in Chapter 4 (i.e., the how versus why task) has proven to be a good manipulation of construal level in lab settings (Freitas et al., 2004), yet whether this is a good intervention method to change long-term behavior in the field remains to be studied. Possibly, in order to realize long-term behavior change, more direct, stronger manipulations are necessary to break old habitual patterns (e.g., real-time feedback in Chapter 5).

Indeed, most pro-environmental behavior is highly habitual, as is the case with energy use behavior. People establish habits at some time in their lives and research shows that it is rather challenging to change such habits (Verplanken & Roy, 2016). Changing people's attitudes or intentions is fairly easy to achieve, and even sparking short-term behavior change is possible. However, establishing long-term behavior change has proven to be more difficult. As such, it remains plausible that people revert to their old habits over a period of time. We address this issue in Chapter 5, where we employed a previously successful method to reduce warm water use (i.e., real-time feedback). We specifically studied the effectiveness of real-time feedback in combination with the same construal level manipulation employed in Chapter 4. Indeed, as compared to the change in water use in Chapter 4 (−13% for the most effective combination), we observed a greater reduction in water use when participants received real-time feedback (−17%) in Chapter 5. We were particularly interested in whether this change in water use would be lasting after participants did not receive feedback any longer. To study this, we only provided participants with real-time feedback for one month and removed the device that provided them with feedback after one month again. In the following month we continued measuring their water use and found that all participants used less water as compared to the baseline period (−10%). However, this study also indicated that all participants changed their behavior after the feedback device had been removed. Yet, what we were most interested in was the effect of our construal level manipulation. We anticipated that habits are activated by particular situational cues, and that the construal level at which people think about their behavior change would thus influence how long-lasting the effect of real-time feedback would be. In terms of the main effect of the construal level manipulation, we did not find significant differences between the low and high construal level manipulation. Nonetheless, similar to the other studies, we found that biospheric values moderated the relation between the construal level manipulations

and water use. The interaction between biospheric values and our construal level manipulations indicated that those who scored higher on biospheric values were affected most by the high construal level manipulation. This suggests that people who think at a high construal level act more upon their values and thus show a lasting change in their behavior.

In sum, our studies show that long-term behavior change can be rather difficult to establish. We attribute this to the highly habitual nature of energy use behavior and although subtle construal level manipulations may prove to be effective in realizing short-term change, long-term change is more challenging. In order to create long-term change, deeply rooted habitual patterns must first be broken, before new, more energy-efficient, habits can be formed. We found that this could be done through real-time feedback and found that in combination with both low and high construal level thinking this is an effective method in realizing long-term behavior change. One important point to stress is that biospheric values, again, determine the magnitude of the long-lasting impact of our interventions. Specifically, in Chapter 5, the higher participants scored on biospheric values the more likely they were to maintain a shorter shower habit when they were exposed to the high construal level manipulation. Therefore, high construal level approaches should be preferred, as these approaches can have more lasting effects, especially among those who value the environment.

6.2.3 Spillover

The third aim of this research was to take potential spillover behavior into account. Across our studies we operationalized spillover in several different manners. As such, we looked at the effect of investments in energy efficiency measures on subsequent curtailment behavior (Chapter 2) and in the remaining chapters we were interested in how an intervention targeted at one behavior (i.e., water use) would affect other energy-related activities (e.g., electricity use; Chapter 3, 4, and 5). Combined, our findings support the overall idea that high construal level manipulations are more likely to lead to positive spillover. However, we also anticipated that low construal level interventions would lead to either negative or no spillover, which we were partially able to substantiate with our current findings. We will discuss our findings in terms of detected spillover effects for both short-term and longer-term behavior change.

6.2.3.1 Short-term behavior

In Chapter 2, we did not specifically operationalize our intervention approaches as construal level manipulations. However, along the lines of construal level theory, we would argue that the financial appeals would be processed at a lower construal level (Hunt et al., 2010) and the environmental appeals at a higher construal level. As we mainly focus on out-of-home situations, we were mainly interested in whether an investment made by others would affect individual energy use behavior. Our results indicate that focusing on the financial benefits when someone else invests in the energy efficiency measure can have negative effects on individual behavior. In contrast to this result, when someone else invested in an energy-efficiency measure for environmental reasons, this had positive effects on behavior. This is in line with our theorizing, as high construal level thinking enables people to see similarities between different types of behaviors and may make them believe that they can also do something about their energy use when they see that someone else invests in energy-efficiency measures. This is also in line with earlier findings (e.g., Evans et al., 2013; Steinhorst, Klöckner, & Matthies, 2015) showing that spillover is more likely to occur when an environmental frame is adopted. In contrast, when someone else invests for monetary reasons, people are more likely to act in a self-interested manner and see potential barriers that may hamper them to act in an energy-saving manner.

In addition, we also showed that the apparent negative spillover effects of a low construal level appeal (i.e., focus on financial benefits) can be combatted when people are given the opportunity to invest in the efficiency measures themselves. Our results thus add to previous findings by showing that actually engaging in a behavior that may be perceived as being environmentally-friendly can have positive effects on behavior later on. As such, participants did score higher on the environmental self-identity scale when they had changed the light bulbs themselves (irrespective of whether it was for financial or environmental reasons). All in all, despite the fact that financial framing can be positive in some cases, it does seem to be more fruitful to focus on the environmental benefits alone, as this will have positive effects on curtailment behavior.

In Chapter 3, we explored the potential spillover to electricity use of construal level messages targeted at water use in a hotel setting. In terms of objectively measured electricity use, we did not find significant differences between the different construal level messages. This is not entirely surprising, as we only expected positive spillover among those who were exposed to the high construal level message. As the high construal level manipulation did not lead to a change in water use behavior, it is unlikely that participants would be motivated to change other energy-related

behaviors. Participants who were exposed to the low construal level message (either as a single message or combined with the high construal level message) only changed their water use behavior when they scored lower on biospheric values. From a construal level theory perspective, we expected either no spillover or negative spillover among those who think at a low construal. The fact that we are unable to find any spillover effects would be in line with our expectations, as people are unlikely to see similarities between different types of behaviors that may serve the same goal (e.g., saving energy) and thereby they are not inclined to change their electricity use when they are prompted to change their water use.

6.2.3.2 Long-term behavior

In both Chapters 4 and 5 we targeted more habitual, long-term behavior and were thus also interested in the potential spillover effects. In both chapters we find support for our hypothesis that high construal level manipulations are more likely to lead to positive spillover to electricity use. In Chapter 4 the spillover effect was mostly driven by one manipulation of construal level (viz., large social distance), and not necessarily the combination of two high construal level manipulations. Based on construal level theory, we argue that high construal level thinking may enable people to see more similarities between different types of behaviors and therefore also improve on other related behavior. Interestingly, in Chapter 4, not all participants reduced their electricity use over time in terms of their socket use, whereas all participants used less electricity for their lights over time. Besides the effect of our construal level manipulation, this finding also provides some insight into the importance of how easy or difficult it is to change different types of behavior. As such, switching lights off when leaving a room is a rather easy behavior change, whereas unplugging devices and switching appliances completely off may require more effort. In their review paper on spillover behavior, Truelove, Carrico, Weber, Raimi, and Vandenbergh (2014) argue that the difficulty of both the initial behavior and the spillover behavior may be important in determining whether negative or positive spillover is more likely to occur. Specifically, they argue that negative spillover is more likely to occur when the secondary behavior is more difficult than the initial behavior.

In Chapter 5, we found evidence for positive spillover for both light use and socket use. All participants displayed an overall downward trend in terms of their electricity use, but participants who had been exposed to the high construal level manipulation decreased their socket use more. Interestingly, similar to the moderating effect of biospheric values on a target behavior, we found that biospheric values interacted with our construal level manipulations. Participants who scored high on

biospheric values and were in the high construal condition, displayed positive spillover, whereas participants who scored high on biospheric values in the low construal level condition were actually more likely to display negative spillover. These findings stress the importance of values, but also the pervasive positive effects of the high construal level condition. Specifically, the high construal level condition enabled all participants to reduce their electricity use, and thus portray positive spillover. Additionally, when participants highly valued the environment this effect was even stronger. However, participants in the low construal level condition seemingly did better on electricity use as well, but our results also indicated that those who scored higher on biospheric values actually show negative spillover to electricity use. Given some self-selection issues in many studies on pro-environmental behavior, this may explain the negative effects of low construal level appeals (e.g., the negative effects of financial appeals; Asensio & Delmas, 2015). As such, low construal level appeals may turn out to be especially ineffective or even have negative effects among people who actually indicate to care about the environment. From a construal level theory perspective this is an interesting finding. Particularly, we did not expect that values would play a significant role when people think at a low construal level. As our findings show clear differences between those who scored lower and higher on biospheric values, we anticipate that the way people think of energy-saving activities in the first place may be determined by how much they care about the environment. In other words, when someone cares a great deal about the environment, this person probably is aware of the different actions that can be taken to reduce the impact on the environment. When this group of people thinks at a low construal level, they may feel they have accomplished their goal and feel like they can lower their effort on other energy-saving activities. People who care less about the environment are not too concerned about different actions they can take in general and may therefore not see any similarities between different types of energy-saving activities. As people are unlikely to see the similarities between different energy-saving actions, we deem it highly unlikely that an intervention targeted at one behavior will spill over (either positive or negative) to other energy-related activities. Due to this baseline difference in how related people think different pro-environmental behaviors are may explain why negative spillover is observed among those who score higher on biospheric values and no spillover is observed among the group that scores relatively lower on biospheric values (i.e., care less about the environment).

In sum, our findings show that high construal level manipulations most likely result in more positive spillover behavior. This is in line with construal level theory, as people are more likely to see similarities between different types of behaviors.

Moreover, similar to the effects on short-term and long-term behavior change, biospheric values are an important factor in determining whether spillover occurs. Even though we found little support for negative spillover effects across our studies, we expected that low construal level interventions would either lead to no spillover, as people do not see the similarities between different types of behaviors, or negative spillover, as people may feel like they have done enough once they have performed better on one behavior. Our findings only show that low construal level approaches can backfire among those who highly value the environment (Chapter 2), but that negative spillover is otherwise not likely to occur.

6.2.4 Construal Level Theory–a useful framework?

Throughout this dissertation we have used construal level theory as our overarching theory to explain energy saving behavior and the effectiveness of interventions in different contexts. Specifically applying construal level manipulations in a field setting adds to previous findings on construal level theory, as previous research has been largely carried out in (online) survey studies or laboratory experiments. Together our studies show that a relatively subtle manipulation of construal level can have real implications in terms of objectively measured energy use.

As we wanted to make use of a theory that was able to address the influence of (biospheric) values, and to predict how combined intervention approaches would work and take the net impact of interventions into account, we considered construal level theory a good fit. In terms of our findings, we observed that the influence of biospheric values was pervasive and our results clearly provide more insights into the kind of circumstances people act upon their values. Moreover, we found that construal level theory is useful in explaining the effectiveness of combined intervention approaches. As such, and in line with previous work, we showed that congruent (high construal level) combinations can be more effective than incongruent combinations. In terms of net impact, our results indicate that the highest net impact can be achieved when a high construal level approach is adopted. Apart from the three key elements we wanted to address with the theory of our choice, we found that another aspect influenced the effectiveness of different intervention approaches: the type of situation. Particularly, we found that when a situation has a longer-term outlook, the manipulations are most effective at a high construal level. In contrast, in a short-term situation, the low construal level manipulations may prove to be especially effective.

Even though we appreciate the application of construal level theory as a general framework, at the same time, our results show that due to the subtlety of many construal level manipulations long-term behavior change in the field may be harder

to achieve. In order to effectively use construal level theory to design effective interventions, the construal level of different approaches should be considered in relation to the type of situation. Though beyond the scope of the current work, it would be worthwhile to make an overview of different intervention methods and classify them along the construal level continuum. Granted that combinations can be more effective, combining interventions based on their construal level would be a worthwhile endeavor based on the results from this dissertation. Given the current standing of research on pro-environmental behavior, a general framework that can classify intervention approaches, as well as different types of behaviors along some form of continuum can help create more uniformity within the field. As it stands now, as energy use behavior is a very applied context, the intervention approaches often used are not based on theoretical considerations, but rather follow popular demand of particular intervention approaches. Finally, we consider construal level theory useful not only for explaining the effectiveness of intervention in the energy use domain, but as a general theory or framework for other domains in which behavioral change is desired. The key factors we deemed important upon choosing a general framework could easily be applied to other contexts in which short-term individual benefits are in conflict with long-term collective benefits, such as health-related behavior, saving and borrowing.

6.3 Methodological issues: Measurement of behavior

In addition to our findings in terms of the effectiveness of construal level manipulations, we were able to compare energy use behavior in terms of self-reported behavior (change) and objectively measured behavior (change). We will elaborate on the convergence between the two measures and provide some explanations in case the measures were not aligned. We will first elaborate on the relation between the baseline measures of energy use. Thereafter, we will discuss whether self-report and objective measures of energy use provided the same results in terms of the direction of behavior change.

First of all, we were able to compare self-reported baseline energy use with objectively measured energy use in that same period. We did this for water use and electricity use in terms of lights and sockets. Important to note is that we were unable to conclude whether people underestimated or overestimated their energy use, because of the use of Likert-type scales, but we were able to get correlations between the two measures. For water use, we could compare objective water use to self-reported shower duration (Chapter 4) and self-reported shower behavior (Chapter 4 and 5). In Chapter 4, we found that the correlation between self-reported shower duration and

objectively measured water use (r = .354) was higher than the correlation between self-reported shower behavior (higher scores indicated that people acted more environmentally-friendly) and the objective measure of water use r = −.142). In Chapter 5, we used the same self-report measure for shower behavior and found a slightly higher correlation with objectively measured water use (r = −.287). This is in line with previous findings, showing that Likert-type items usually result in relatively low correlations with objective measures of energy use (Kormos & Gifford, 2014). Previous studies have found correlations between self-reported and objectively measured water use of around r = .29 (Kormos & Gifford, 2014), which is very close to our correlation in Chapter 5. Our results are thus in line with previous findings, showing that the two measures do significantly correlate, but a large portion of unexplained variance remains.

A second issue we could address was whether the change in energy use was similar between the two measures of behavior. In terms of water use in Chapter 4, we did find that those in the high construal level condition indicated to take shorter showers, whereas participants in the low construal level condition actually indicated that they took longer showers. This is somewhat in the same direction as the effects on the objective measures, as the congruent high construal level combination most effectively reduced water use. However, on other measures we found rather diverging results. As such, in Chapter 4 we found that participants in the low construal level conditions indicated to do better on their self-reported shower behavior and appliance use, but this did not correspond with the objectively measured energy use. Specifically, participants in the low construal level conditions did not seem to improve on their objectively measured behavior at all, whereas the self-report measures indicated they did. Likewise, in Chapter 5, we found that participants in the low construal level condition indicated to improve more on their shower behavior as compared to participants in the high construal level condition. The objective measures did not show a significant difference between the two conditions, and if anything, actually pointed in the opposite direction. These results may suggest that low construal level manipulations may make people more susceptible to report that they did better on the targeted behavior.

In sum, what we can gather from these results is that low construal level manipulations often lead to the desired behavior change on self-report measures, but this is not necessarily translated into actual behavior. As noted in the introduction, this may either be due to self-deceptive enhancement mechanisms or impression management (Lalwani et al., 2009; Paulhus, 2002). Although previous research has indicated that social desirability does not seem to be an issue with reporting of pro-

environmental behavior in general (Milfont, 2009), it may be more of an issue when this behavior is specifically targeted and people are asked at a second occasion about their improvement on that particular behavior. As such, our results indicate that when people are given a very concrete, low level manipulation, they may feel more inclined to answer according to the intention of the experiment; which is more reminiscent of impression management than of self-deceptive enhancement. However, we did not specifically study this issue, and are not able to tease apart the exact cause of the divergence of findings between self-report and objective measures of behavior. A more elaborate study on the convergence between self-report and objective measures would be very valuable, especially on the change in energy use and whether the two measures result in the same conclusion or lead to opposite findings.

6.4 Limitations and future research

Across our studies we investigated the effectiveness of interventions targeted at energy use and have used a plurality of methods (e.g., laboratory experiments and field experiments) and operationalizations (e.g., social distance and direct construal level manipulations) to gain understanding in the workings of (combined) construal level interventions. In the following we will discuss the limitations of the current findings pertaining to monitoring issues and our operationalizations of construal level manipulations.

6.4.1 Awareness of being monitored

In all of our studies we were able to obtain objective measures of energy use, which allowed us to test the effectiveness of our interventions without solely relying on self-reported behavior change. Even though self-report measures are susceptible to some social desirability issues, it has been noted that the mere fact that people are being monitored may influence how people behave. This has been referred to as the Hawthorne-effect (see McCambridge et al., 2014). We fully acknowledge that this may be a concern across our studies, but also trust our findings as we were mostly interested in the differences between conditions. As such, the Hawthorne-effect may have already influenced energy use behavior in a positive manner (i.e., people start using less energy because they know they are being monitored), and the observed differences between our conditions are really only in addition to this effect. Moreover, previous research on the Hawthorne effect in reference to electricity use has shown that the mere fact of being aware of being monitored resulted in a 2.7% decrease in electricity use (Schwartz et al., 2013). Even though the latter finding in terms of electricity use reduction was significant, it is far smaller than the observed effects in our studies. We

thus argue that our results can be seen as a rather conservative test of the effectiveness of our manipulations, as part of the change in behavior may have been due to the awareness of being monitored, which would be the same across all participants. Moreover, when possible we included a control condition, in which participants were aware of being monitored, but did not receive any intervention targeted at their energy use behavior. In Chapter 4, we actually observe an overall upward trend in water use in the control group, suggesting that the Hawthorne effect is either not present or only has an influence on the energy use in the beginning of the experiment. Future research should study whether the notion of being monitored actually has a positive, negative or no effect on behavior when combined with construal level manipulations.

6.4.2 Construal level manipulations

In Chapters 4 and 5, we applied a construal level manipulation, that is usually used in lab settings (i.e., how vs. why task; Freitas, Gollwitzer, & Trope, 2004), in a field setting, and were able to show that this rather subtle manipulation has an effect on objectively measured water and energy use. As mentioned, whether this subtle manipulation alone is enough to stimulate long-term behavior change remains to be studied, but we were able to show that in combination with other manipulations it can be an effective method.

Next to this commonly used direct manipulation of construal level, we also operationalized more indirect manipulations of construal level by appealing to the social distance of providing people with rewards to self or other (Chapter 4) and highlighting benefits to self or to the environment (Chapters 2 and 3). We argued that messages that are either highlighting benefits to the self (e.g., financial or health benefits) or to the environment differ in social distance. Specifically, we argued that benefits to self are represented at a low construal level, which is in line with earlier work by Hunt et al. (2010). We tried to ascertain that we indeed manipulated social distance in Chapter 3 and showed that participants thought that health messages highlighted benefits to self the most, whereas environmental messages mostly highlighted benefits to others and society at large.

However, it could be that other considerations also play a role that may determine the effectiveness of these appeals. As such, it has been argued that environmental and self-interested (e.g., health or financial) appeals may not only differ in terms of their social distance (i.e., how far removed the consequences of the behavior are to the person), but also in terms of pro-sociality and self-interest. We do not contest this perspective, but argue that both processes may occur at the same time and may reinforce one another. As such, high construal level thinking is associated with a

broader focus and not surprisingly this may correspond more with pro-social considerations than with pro-self considerations. In contrast, when people think at a low construal level, their focus is narrower, and they may focus solely on the benefits that can be derived for themselves. This reasoning is in line with earlier work from Goldsmith et al. (2016) who argue that self-transcendent (e.g., environmental) values correspond with high construal level thinking, whereas self-enhancement values are more in line with low construal level thinking. We follow this line of reasoning and go one step further by arguing that appealing to either self-transcendent or self-interest values influences the construal level at which people process these benefits. Much like Chang, Zhang, & Xie (2015) have argued that loss and gain frames are associated negative and positive feelings, which in turn evoke either low or high construal level thinking, respectively, we argue that a similar process occurs when different benefits are highlighted. That being said, more research is needed to tease apart the differences between pure construal level manipulations and manipulations that influence construal level, but that trigger other mechanisms at the same time. We suggest that as long as these mechanisms are aligned in terms of the associated construal level, this will not be problematic. Moreover, as we were unable to put clear manipulation checks in the studies, future research should focus on how to measure a change in construal level. We have tried to account for baseline construal level differences by employing the Behavior Identification Form (BIF; Vallacher & Wegner, 1989). This measure is most commonly used as a trait measure of level of abstraction, and even though participants were asked to fill out the BIF in both the pre- and post-intervention survey, this measure could not function as a manipulation check. In laboratory settings, manipulation checks of construal level may be easier to employ, but even in those settings it remains a challenge to have a clear manipulation check of construal level. The difficulty with manipulation checks for construal level is that the mere question on construal level may influence the manipulation itself. Additionally, people may not be aware of their construal level, which makes it harder to test whether construal level is effectively manipulated. Future research should focus on how to measure a change in construal level to make sure that construal level is indeed manipulated in order to rule out the causal effects of other mechanisms.

6.5 Practical implications

Practically, the findings from this research are important for researchers and policy makers in the realm of energy use behavior when people do not personally benefit from reducing their energy use. As we specifically focused on the effectiveness of interventions, we can provide four clear practical implications. First of all, in the

design process of interventions targeted at energy use, it is advised to take the construal level of the different intervention approaches into account. Our research suggests that combinations should be made at the same construal level.

Secondly, in deciding whether high or low construal level approaches or combinations thereof should be preferred depends on the situation that is targeted. As such, when short-term situations are targeted, low construal level approaches can be particularly effective. This is especially the case among people who do not highly value the environment, and who might otherwise be unlikely to change their behavior. However, when long-term change is desirable, high construal level manipulations are more likely to lead to the intended behavior change. As such, high construal level approaches may make people less susceptible to situational influences and people are more likely to display positive spillover behavior.

Thirdly, how much people value the environment can be a defining factor in how effective different intervention methods are. In general, people who highly value the environment, may act more upon their values when they think at a high construal level and have the potential to create long-lasting change. However, people who do not highly value the environment may respond differently to interventions. This is an interesting group of people, as they are usually not inclined to act in a pro-environmental manner. We found that people who do not highly value the environment can be motivated to reduce their energy use when low construal level benefits were communicated to them in a short-term situation. In longer-term situations, high construal level approaches did seem to be more fruitful. Moreover, for people who highly value the environment, high construal level approaches were most effective. The low construal level approaches sometimes even proved to be ineffective among people who highly valued the environment, which is in line with previous research showing negative effects of using low construal level (i.e., financial) appeals (Asensio & Delmas, 2015). Therefore, when designing interventions targeted at long-term behavior change it is probably best to focus on high construal level approaches and use combinations that are at the same construal level. For short-term change, or one-off decisions, both high and low construal level approaches may be effective, but among people who do not highly value the environment low construal level approaches can be effective to spark short-term behavior change.

Finally, in the design of interventions and in determining whether interventions have proven to be effective it is essential to have appropriate baseline measures. We took baseline measures across our studies, and were able to conclude whether a change occurred, and consider this to be essential in evaluating the effectiveness of different approaches.

6.6 Conclusion

Even though much previous work has focused on residential energy use, people spend a great portion of their day outside their home, while individuals are often still the end-user of energy (e.g., electricity, water) in such out–of-home situations. This dissertation therefore aimed to provide more insight in how energy saving behavior can be stimulated in such situations in which "others pay the bill." We applied construal level theory as a general framework to classify intervention approaches and to understand how different approaches affect short-term, long-term and spillover behavior. Moreover, we were interested in the effectiveness of combined intervention approaches and show that construal level may play an important role in determining whether intervention approaches enforce one another or actually invalidate the effectiveness of each individual manipulation. Our findings suggest that combinations are most effective when they are at the same construal level. Additionally, in order to determine whether high or low construal level approaches are more effective one should be aware of a number of factors. As such, we show that it is important to take the type of situation into account (e.g., a short-term hotel visit is better aligned with a low construal level), how much people value the environment (e.g., is there still room for improvement?) and whether spillover effects are also desirable (e.g., high construal level thinking facilitates more positive spillover). Finally, throughout this dissertation we have focused on the effects of interventions on objectively measured behavior and consider this an important feature to focus on. We think that future work would highly benefit from using objective measures of behavior in order to understand what kind of methods have the most long-lasting effect across multiple energy-related and pro-environmental behaviors.

References

Aarts, H., Verplanken, B., & Knippenberg, A. (1998). Predicting behavior from actions in the past: Repeated decision making or a matter of habit? *Journal of Applied Social Psychology*, *28*(15), 1355–1374. http://doi.org/10.1111/j.1559-1816.1998.tb01681.x

Abrahamse, W., Steg, L., Vlek, C., & Rothengatter, T. (2005). A review of intervention studies aimed at household energy conservation. *Journal of Environmental Psychology*, *25*(3), 273–291. http://doi.org/10.1016/j.jenvp.2005.08.002

Ajzen, I. (1985). From Intentions to Actions: A Theory of Planned Behavior. In *Action Control* (pp. 11–39). Berlin, Heidelberg: Springer Berlin Heidelberg. http://doi.org/10.1007/978-3-642-69746-3_2

Allcott, H. (2009). Social norms and energy conservation. *Center for Energy and Environmental Policy Research*, (October), 1–35. http://doi.org/10.1016/j.jpubeco.2011.03.003

Allcott, H. (2011). Social norms and energy conservation. *Journal of Public Economics*, *95*(9–10), 1082–1095. http://doi.org/10.1016/j.jpubeco.2011.03.003

Allcott, H., & Rogers, T. (2012). The short-run and long-run effects of behavioral interventions : Experimental evidence from energy conservation, 1–65. http://doi.org/10.1257/aer.104.10.3003

Amit, E., Algom, D., & Trope, Y. (2009). Distance-dependent processing of pictures and words. *Journal of Experimental Psychology: General*, *138*(3), 400–415. http://doi.org/10.1037/a0015835

Asensio, O. I., & Delmas, M. A. (2015). Nonprice incentives and energy conservation. *Proceedings of the National Academy of Sciences*, *112*(6), E510–E515. http://doi.org/10.1073/pnas.1401880112

Attari, S. Z. (2014). Perceptions of water use. *Proceedings of the National Academy of Sciences*, *111*(14), 5129–5134. http://doi.org/10.1073/pnas.1316402111

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. http://doi.org/10.1073/pnas.1001509107

Baca-Motes, K., Brown, A., Gneezy, A., Keenan, E. A., & Nelson, L. D. (2012). Commitment and Behavior Change: Evidence from the Field. *Journal of Consumer Research*, *39*(5), 1070–1084. http://doi.org/10.1086/667226

Bain, P. G., Milfont, T. L., Kashima, Y., Bilewicz, M., Doron, G., Garðarsdóttir, R. B., … Saviolidis, N. M. (2016). Co-benefits of addressing climate change can motivate action around the world. *Nature Climate Change*, *6*(2), 154–157. http://doi.org/10.1038/nclimate2814

Bar-Anan, Y., Liberman, N., Trope, Y., & Algom, D. (2007). Automatic processing of psychological distance: evidence from a Stroop task. *Journal of Experimental Psychology. General*, *136*(4), 610–22. http://doi.org/10.1037/0096-3445.136.4.610

Bardi, A., Lee, J. A., Hofmann-Towfigh, N., & Soutar, G. (2009). The structure of intraindividual value change. *Journal of Personality and Social Psychology*, *97*(5), 913–29. http://doi.org/10.1037/a0016617

Bates, D., Mächler, M., Bolker, B., & Walker, S. (2014). Fitting Linear Mixed-Effects Models using lme4. Retrieved from http://arxiv.org/abs/1406.5823

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

References

Biel, A., & Dahlstrand, U. (2005). Values and habits: A dual-process model. In S. Krarup & C. S. Russell (Eds.), *Environment, Information and Consumer Behavior* (pp. 33–50). Cheltenham: Edward Elgar.

Bittle, R. G., Valesano, R., & Thaler, G. (1979). The effects of daily cost feedback on residential electricity consumption. *Behavior Modification*, *3*(2), 187–202. http://doi.org/10.1177/014544557932004

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. http://doi.org/10.1177/0146167215572134

Bolderdijk, J. W., Gorsira, M., Keizer, K., & Steg, L. (2013). Values determine the (in)effectiveness of informational interventions in promoting pro-environmental behavior. *PLoS ONE*, *8*(12), 1–7. http://doi.org/10.1371/journal.pone.0083911

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. http://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. http://doi.org/10.1038/nclimate1767

Brügger, A., Dessai, S., Devine-Wright, P., Morton, T. A., & Pidgeon, N. F. (2015). Psychological responses to the proximity of climate change. *Nature Climate Change*, *5*(12), 1031–1037. http://doi.org/doi:10.1038/nclimate2760

Carmi, N., & Kimhi, S. (2015). Further than the eye can see: Psychological distance and perception of environmental threats. *Human and Ecological Risk Assessment: An International Journal*, *21*(8), 2239–2257. http://doi.org/10.1080/10807039.2015.1046419

Chang, H., Zhang, L., & Xie, G. X. (2015). Message framing in green advertising: The effect of construal level and consumer environmental concern. *International Journal of Advertising*, *34*(1), 158–176. http://doi.org/10.1080/02650487.2014.994731

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. http://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. http://doi.org/10.1037/0022-3514.69.2.318

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). *Applied multiple regression/correlation analysis for the behavioral sciences*. Mahwah, New Jersey: Lawrence Erlbaum Associates.

Conway, P., & Peetz, J. (2012). When does feeling moral actually make you a better person? Conceptual abstraction moderates whether past moral deeds motivate consistency or compensatory behavior. *Personality and Social Psychology Bulletin*, *38*(7), 907–919. http://doi.org/10.1177/0146167212442394

Corner, A., Markowitz, E., & Pidgeon, N. (2014). Public engagement with climate change: the role of human values. *Wiley Interdisciplinary Reviews: Climate Change*, *5*(3), 411–422. http://doi.org/10.1002/wcc.269

Dahlstrand, U., & Biel, A. (1997). Pro-environmental habits: Propensity levels in behavioral change. *Journal of Applied Social Psychology*, *27*, 588–601. http://doi.org/10.1111/j.1559-1816.1997.tb00650.x

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. http://doi.org/10.1177/0013916506297831

de Groot, J. I. M., & Steg, L. (2010). Relationships between value orientations, self-determined motivational types and pro-environmental behavioural intentions. *Journal of Environmental Psychology*, *30*(4), 368–378. http://doi.org/10.1016/j.jenvp.2010.04.002

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. http://doi.org/10.1037/0033-2909.125.6.627

Deci, E. L., & Ryan, R. (1985). *Intrinsic motivation and self-determination in human behavior*. Springer Science & Business Media. Retrieved from https://books.google.nl/books?hl=nl&lr=&id=p96Wmn-ER4QC&oi=fnd&pg=PA1&dq=deci+ryan+1985&ots=3eHMu1n997&sig=2s9hGvv2algc-ofzNvwqAmsfXcg

Delmas, M. A., Fischlein, M., & Asensio, O. I. (2013). Information strategies and energy conservation behavior: A meta-analysis of experimental studies from 1975 to 2012. *Energy Policy*, *61*(1), 729–739. http://doi.org/10.1016/j.enpol.2013.05.109

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. http://doi.org/10.1073/pnas.0908738106

Dogan, E., Bolderdijk, J. W., & Steg, L. (2014). Making small numbers count: Environmental and financial feedback in promoting eco-driving behaviours. *Journal of Consumer Policy*, *37*(3), 413–422. http://doi.org/10.1007/s10603-014-9259-z

Dolan, P., & Galizzi, M. M. (2015). Like ripples on a pond: Behavioral spillovers and their implications for research and policy. *Journal of Economic Psychology*, *47*, 1–16. http://doi.org/10.1016/j.joep.2014.12.003

EIA. (2018). Monthly energy review - Energy information administration. Retrieved April 6, 2018, from https://www.eia.gov/totalenergy/data/monthly/#consumption

Eurostat. (2009). MEDSTAT II: "Water and Tourism" pilot study. *Eurostat, European Commission*. Retrieved from http://ec.europa.eu/eurostat/documents/3888793/5844489/KS-78-09-699-EN.PDF/04c900a4-6243-42e0-969f-fc04f184a8b6

Eurostat. (2018). Energy trends - Statistics Explained. Retrieved April 4, 2018, from http://ec.europa.eu/eurostat/statistics-explained/index.php/Energy_trends

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. http://doi.org/10.1038/nclimate1662

References

Eyal, T., Sagristano, M. D., Trope, Y., Liberman, N., & Chaiken, S. (2009). When values matter: Expressing values in behavioral intentions for the near vs. distant future. *Journal of Experimental Social Psychology*, *45*(1), 35–43. http://doi.org/10.1016/j.jesp.2008.07.023

Festinger, L. (1954). A theory of social comparison processes. *Human Relations*, *7*(2), 117–140. http://doi.org/10.1177/001872675400700202

Fischer, C. (2008). Feedback on household electricity consumption: A tool for saving energy? *Energy Efficiency*, *1*(1), 79–104. http://doi.org/10.1007/s12053-008-9009-7

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior: an introduction to theory and research*. Addison-Wesley Pub. Co.

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

Frederiks, E. R., Stenner, K., & Hobman, E. V. (2015a). Household energy use: Applying behavioural economics to understand consumer decision-making and behaviour. *Renewable and Sustainable Energy Reviews*, *41*, 1385–1394. http://doi.org/10.1016/j.rser.2014.09.026

Frederiks, E. R., Stenner, K., & Hobman, E. V. (2015b). The socio-demographic and psychological predictors of residential energy consumption: A comprehensive review. *Energies*, *8*(1), 573–609. http://doi.org/10.3390/en8010573

Frederiks, E. R., Stenner, K., Hobman, E. V, & Fischle, M. (2016). Evaluating energy behavior change programs using randomized controlled trials: Best practice guidelines for policymakers. *Energy Research & Social Science*, *22*, 147–164. http://doi.org/10.1016/j.erss.2016.08.020

Freitas, A. L., Gollwitzer, P., & Trope, Y. (2004). The influence of abstract and concrete mindsets on anticipating and guiding others' self-regulatory efforts. *Journal of Experimental Social Psychology*, *40*(6), 739–752. http://doi.org/10.1016/j.jesp.2004.04.003

Fujii, S., & Kitamura, R. (2003). What does a one-month free bus ticket do to habitual drivers? An experimental analysis of habit and attitude change. *Transportation*, *30*(1), 81–95. http://doi.org/10.1023/A:1021234607980

Fujita, K., Clark, S. L., & Freitas, A. L. (2013). "Think globally, act locally": Construal levels and environmentally relevant decision-making. In H. C. M. van Trijp (Ed.), *Encouraging Sustainable Behavior* (1st ed., pp. 81–100). New York: Psychology Press.

Fujita, K., Eyal, T., Chaiken, S., Trope, Y., & Liberman, N. (2008). Influencing attitudes toward near and distant objects. *Journal of Experimental Social Psychology*, *44*(3), 562–572. http://doi.org/10.1016/j.jesp.2007.10.005

Fujita, K., Trope, Y., Liberman, N., & Levin-Sagi, M. (2006). Construal levels and self-control. *Journal of Personality and Social Psychology*, *90*(3), 351–67. http://doi.org/10.1037/0022-3514.90.3.351

Gärling, T., & Schuitema, G. (2007). Travel demand management targeting reduced private car use: Effectiveness, public acceptability and political feasibility. *Journal of Social Issues*, *63*(1), 139–153. http://doi.org/http://dx.doi.org/10.1111/j.1540-4560.2007.00500.x

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. http://doi.org/10.1509/jppm.16.096

Gatersleben, B., Steg, L., & Vlek, C. (2002). Measurement and determinants of environmentally significant consumer behavior. *Environment and Behavior*, *34*(3), 335–362. http://doi.org/10.1177/0013916502034003004

Giacomantonio, M., De Dreu, C. K. W., Shalvi, S., Sligte, D., & Leder, S. (2010). Psychological distance boosts value-behavior correspondence in ultimatum bargaining and integrative negotiation. *Journal of Experimental Social Psychology*, *46*(5), 824–829. http://doi.org/10.1016/j.jesp.2010.05.001

Gifford, R. (2011). The dragons of inaction: psychological barriers that limit climate change mitigation and adaptation. *The American Psychologist*, *66*(4), 290–302. http://doi.org/10.1037/a0023566

Gifford, R., & Nilsson, A. (2014). Personal and social factors that influence pro-environmental concern and behaviour: A review. *International Journal of Psychology*, *49*(3), 141–157. http://doi.org/10.1002/ijop.12034

Gifford, R., Scannell, L., Kormos, C., Smolova, L., Biel, A., Boncu, S., … Uzzell, D. (2009). Temporal pessimism and spatial optimism in environmental assessments: An 18-nation study. *Journal of Environmental Psychology*, *29*(1), 1–12. http://doi.org/10.1016/j.jenvp.2008.06.001

Goldsmith, K., Newman, G. E., & Dhar, R. (2016). Mental representation changes the evaluation of green product benefits. *Nature Climate Change*, *6*(9), 847–850. http://doi.org/10.1038/nclimate3019

Goldstein, N. J., Cialdini, R. B., & Griskevicius, V. (2008). A Room with a Viewpoint: Using Social Norms to Motivate Environmental Conservation in Hotels. *Journal of Consumer Research*, *35*(3), 472–482. http://doi.org/10.1086/586910

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

Griffioen, A. M., Handgraaf, M. J. J., & Antonides, G. (n.d.). Which construal level combinations are most effective? A field experiment on energy conservation. *Under Review at PLoS ONE*.

Griffioen, A. M., van Beek, J., Lindhout, S. N., & Handgraaf, M. J. J. (2016). Distance makes the mind grow broader: An overview of psychological distance studies in the environmental and health domains. *APSTRACT: Applied Studies in Agribusiness and Commerce*, *10*(2–3), 27–32.

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. http://doi.org/10.1002/9781118926352.ch27

Handgraaf, M. J. J., van Lidth de Jeude, M. A., & Appelt, K. C. (2013). Public praise vs. private pay: Effects of rewards on energy conservation in the workplace. *Ecological Economics*, *86*, 86–92. http://doi.org/10.1016/j.ecolecon.2012.11.008

Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. New York: Guilford Press.

References

Hermsen, S., Frost, J., Renes, R. J., & Kerkhof, P. (2016). Using feedback through digital technology to disrupt and change habitual behavior: A critical review of current literature. *Computers in Human Behavior*, *57*, 61–74. http://doi.org/10.1016/j.chb.2015.12.023

Hunt, C. V., Kim, A., Borgida, E., & Chaiken, S. (2010). Revisiting the self-interest versus values debate: The role of temporal perspective. *Journal of Experimental Social Psychology*, *46*(6), 1155–1158. http://doi.org/10.1016/j.jesp.2010.05.004

Jakovcevic, A., Steg, L., Mazzeo, N., Caballero, R., Franco, P., Putrino, N., & Favara, J. (2014). Charges for plastic bags: Motivational and behavioral effects. *Journal of Environmental Psychology*, *40*, 372–380. http://doi.org/10.1016/j.jenvp.2014.09.004

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

Jones, C., Hine, D. W., & Marks, A. D. G. (2017). The future is now: Reducing psychological distance to increase public engagement with climate change. *Risk Analysis*, *37*(2), 331–341. http://doi.org/10.1111/risa.12601

Kappel, K., & Grechenig, T. (2009). "Show-me": Water consumption at a glance to promote water conservation in the shower. In *Proceedings of the 4th International Conference on Persuasive Technology - Persuasive '09* (p. 1). New York, New York, USA: ACM Press. http://doi.org/10.1145/1541948.1541984

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. http://doi.org/10.1177/0013916512467532

Katzev, R. D., & Johnson, T. R. (1983). A social-psychological analysis of residential electricity consumption: the impact of minimal justification techniques. *Journal of Economic Psychology*, *3*(3–4), 267–284. http://doi.org/10.1016/0167-4870(83)90006-5

Klein, S. A., Hilbig, B. E., & Heck, D. W. (2017). Which is the greater good? A social dilemma paradigm disentangling environmentalism and cooperation. *Journal of Environmental Psychology*, *53*, 40–49. http://doi.org/10.1016/j.jenvp.2017.06.001

Klöckner, C. A. (2013). A comprehensive model of the psychology of environmental behaviour-A meta-analysis. *Global Environmental Change*, *23*(5), 1028–1038. http://doi.org/10.1016/j.gloenvcha.2013.05.014

Kollmuss, A., & Agyeman, J. (2002). Mind the gap: Why do people act environmentally and what are the barriers to pro-environmental behavior? *Environmental Education Research*, *8*(2), 239–260. http://doi.org/10.1080/1350462022014540

Kormos, C., & Gifford, R. (2014). The validity of self-report measures of proenvironmental behavior: Ameta-analytic review. *Journal of Environmental Psychology*, *40*, 359–371. http://doi.org/10.1016/j.jenvp.2014.09.003

Kuznetsov, S., & Paulos, E. (2010). UpStream: Motivating water conservation with low-cost water flow sensing and persuasive displays. In *Proceedings of the 28th international conference on Human factors in computing systems - CHI '10* (p. 1851). New York, New York, USA: ACM Press. http://doi.org/10.1145/1753326.1753604

Labroo, A. A., & Patrick, V. M. (2009). Psychological distancing: Why happiness helps you see the big picture. *Journal of Consumer Research*, *35*(5), 800–809. http://doi.org/10.1086/593683

Lally, P., & Gardner, B. (2013). Promoting habit formation. *Health Psychology Review*, *7*(June), S137–S158. http://doi.org/10.1080/17437199.2011.603640

Lalwani, A. K., Shrum, L. J., & Chiu, C.-Y. (2009). Motivated response styles: the role of cultural values, regulatory focus, and self-consciousness in socially desirable responding. *Journal of Personality and Social Psychology*, *96*(4), 870–82. http://doi.org/10.1037/a0014622

Lazar, A. P., & Lazar, P. (1991). Dry skin, water, and lubrication. *Dermatologic Clinics*, *9*(1), 45–51.

Ledgerwood, A., Trope, Y., & Chaiken, S. (2010). Flexibility now, consistency later: Psychological distance and construal shape evaluative responding. *Journal of Personality and Social Psychology*, *99*(1), 32–51. http://doi.org/10.1037/a0019843

Lee, A. Y., & Aaker, J. L. (2004). Bringing the frame into focus: The influence of regulatory fit on processing fluency and persuasion. *Journal of Personality and Social Psychology*, *86*(2), 205–218. http://doi.org/10.1037/0022-3514.86.2.205

Leiserowitz, A. (2006). Climate change risk perception and policy preferences: The role of affect, imagery, and values. *Climatic Change*, *77*(1–2), 45–72. http://doi.org/10.1007/s10584-006-9059-9

Leiserowitz, A. A. (2005). American risk perceptions: Is climate change dangerous? *Risk Analysis*, *25*(6), 1433–1442. http://doi.org/10.1111/j.1540-6261.2005.00690.x

Libby, L. K., Shaeffer, E. M., & Eibach, R. P. (2009). Seeing meaning in action: a bidirectional link between visual perspective and action identification level. *Journal of Experimental Psychology: General*, *138*(4), 503–516. http://doi.org/10.1037/a0016795

Liberman, N., & Trope, Y. (1998). The role of feasibility and desirability considerations in near and distant future decisions: A test of temporal construal theory. *Journal of Personality and Social Psychology*, *75*(1), 5–18. http://doi.org/10.1037/0022-3514.75.1.5

Liberman, N., Trope, Y., McCrea, S. M., & Sherman, S. J. (2007). The effect of level of construal on the temporal distance of activity enactment. *Journal of Experimental Social Psychology*, *43*, 143–149. http://doi.org/10.1016/j.jesp.2005.12.009

Loock, C.-M., Staake, T., & Thiesse, F. (2013). Motivating energy-efficient behavior with green IS: an investigation of goal setting and the role of defaults. *MIS Quarterly*, *37*(4), 1313-A5. http://doi.org/10.1029/2012WR012398

MacDonnell, R., & White, K. (2015). How construals of money versus time impact consumer charitable giving. *Journal of Consumer Research*, *42*(4), 551–563. http://doi.org/10.1093/jcr/ucv042

Maio, G. R., Pakizeh, A., Cheung, W. Y., & Rees, K. J. (2009). Changing, priming, and acting on values: effects via motivational relations in a circular model. *J Pers Soc Psychol*, *97*(4), 699–715. http://doi.org/10.1037/a0016420

McCambridge, J., Witton, J., & Elbourne, D. R. (2014). Systematic review of the Hawthorne effect: New concepts are needed to study research participation effects. *Journal of Clinical Epidemiology*, *67*, 267–277. http://doi.org/10.1016/j.jclinepi.2013.08.015

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

References

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*. http://doi.org/10.4324/9780203141182

Milfont, T. L. (2009). The effects of social desirability on self-reported environmental attitudes and ecological behaviour. *Environmentalist*, *29*, 263–269. http://doi.org/10.1007/s10669-008-9192-2

Monin, B., & Miller, D. T. (2001). Moral credentials and the expression of prejudice. *Journal of Personality and Social Psychology*, *81*(1), 33–43. http://doi.org/10.1037/0022-3514.81.1.33

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

Newell, B. R., McDonald, R. I., Brewer, M., & Hayes, B. K. (2014). The psychology of environmental decisions. *Annual Review of Environment and Resources*, *39*(1), 443–467. http://doi.org/10.1146/annurev-environ-010713-094623

Nilsson, A., Bergquist, M., & Schultz, W. P. (2017). Spillover effects in environmental behaviors, across time and context: a review and research agenda. *Environmental Education Research*, *23*(4), 573–589. http://doi.org/10.1080/13504622.2016.1250148

Nilsson, A., Von Borgstede, C., & Biel, A. (2004). Willingness to accept climate change strategies: The effect of values and norms. *Journal of Environmental Psychology*, *24*, 267–277. http://doi.org/10.1016/j.jenvp.2004.06.002

Nolan, J. M., Schultz, P. W., Cialdini, R. B., Goldstein, N. J., & Griskevicius, V. (2008). Normative social influence is underdetected. *Personality & Social Psychology Bulletin*, *34*(7), 913–23. http://doi.org/10.1177/0146167208316691

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

Obradovich, N., & Guenther, S. M. (2016). Collective responsibility amplifies mitigation behaviors. *Climatic Change*, *137*(1–2), 307–319. http://doi.org/10.1007/s10584-016-1670-9

Osbaldiston, R., & Schott, J. P. (2012). Environmental Sustainability and Behavioral Science: Meta-Analysis of Proenvironmental Behavior Experiments. *Environment and Behavior*, *44*(2), 257–299. http://doi.org/10.1177/0013916511402673

Paulhus, D. L. (2002). Socially desirable responding: The evolution of a construct. In H. I. Braun, D. N. Jackson, & D. E. Wiley (Eds.), *The Role of Constructs in Psychological and Educational Measurement* (pp. 49–69). Mahwah, NJ: Erlbaum. Retrieved from http://www2.psych.ubc.ca/~dpaulhus/research/CIRCUMPLEX/ETS chapter.pdf

Peng, J., He, F., Zhang, Y., Liu, Q., Miao, D., & Xiao, W. (2013). Differences in simulated doctor and patient medical decision making: A construal level perspective. *PLoS ONE*, *8*(11). http://doi.org/10.1371/journal.pone.0079181

Peters, A. M., van der Werff, E., & Steg, L. (2018). Beyond purchasing: Electric vehicle adoption motivation and consistent sustainable energy behaviour in The Netherlands. *Energy Research & Social Science*, *39*, 234–247. http://doi.org/10.1016/j.erss.2017.10.008

Petty, R. E., & Cacioppo, J. T. (1986). The Elaboration Likelihood Model of Persuasion. In *Communication and Persuasion* (pp. 1–24). New York, NY: Springer New York. http://doi.org/10.1007/978-1-4612-4964-1_1

Rabinovich, A., Morton, T. A., Postmes, T., & Verplanken, B. (2009). Think global, act local: The effect of goal and mindset specificity on willingness to donate to an environmental organization. *Journal of Environmental Psychology*, *29*(4), 391–399. http://doi.org/10.1016/j.jenvp.2009.09.004

Raven Housing Trust. (2013). *Save Money Save Energy Save the Environment*. Redhill, UK. Retrieved from http://www.ravenht.org.uk/data/files/resources/98/Save-money-energy-environment-Oct-13.pdf

Ritchie, J. R. B., & McDougall, G. H. G. (1985). Designing and marketing consumer energy conservation policies and programs: Implications from a decade of research. *Journal of Public Policy & Marketing*, *4*, 14–32. http://doi.org/10.2307/30000071

Ruepert, A. M., Keizer, K., & Steg, L. (2017). The relationship between Corporate Environmental Responsibility, employees' biospheric values and pro-environmental behaviour at work. *Journal of Environmental Psychology*, *54*, 65–78. http://doi.org/10.1016/j.jenvp.2017.10.006

Schoenefeld, J. J., & McCauley, M. R. (2015). Local is not always better: the impact of climate information on values, behavior and policy support. *Journal of Environmental Studies and Sciences*. http://doi.org/10.1007/s13412-015-0288-y

Schultz, P. W. (2001). The structure of environmental concern: Concern for self, other people, and the biosphere. *Journal of Environmental Psychology*, *21*(4), 327–339. http://doi.org/10.1006/jevp.2001.0227

Schultz, P. W., Estrada, M., Schmitt, J., Sokoloski, R., & Silva-Send, N. (2015). Using in-home displays to provide smart meter feedback about household electricity consumption: A randomized control trial comparing kilowatts, cost, and social norms. *Energy*, *90*, 351–358. http://doi.org/10.1016/j.energy.2015.06.130

Schultz, P. W., Messina, A., Tronu, G., Limas, E. F., Gupta, R., & Estrada, M. (2016). Personalized normative feedback and the moderating role of personal norms: A field experiment to reduce residential water consumption. *Environment and Behavior*, *48*(5), 686–710. http://doi.org/10.1177/0013916514553835

Schultz, P. W., Nolan, J. M., Cialdini, R. B., Goldstein, N. J., & Griskevicius, V. (2007). Research Article: The Constructive, Destructive, and Reconstructive Power of Social Norms. *Psychological Science*, *18*(5), 429. http://doi.org/10.1111/j.1467-9280.2007.01917.x

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. http://doi.org/10.1037/xap0000042

Schwartz, D., Fischhoff, B., Krishnamurti, T., & Sowell, F. (2013). The Hawthorne effect and energy awareness. *Source: Proceedings of the National Academy of Sciences of the United States of America*, *110*(38), 15242–15246. Retrieved from http://www.jstor.org/stable/42713307

Schwartz, S. H. (1977). Normative influences on altruism. *Advances in Experimental Social Psychology*, *10*, 221–279. http://doi.org/10.1016/S0065-2601(08)60358-5

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). http://doi.org/10.1016/S0065-2601(08)60281-6

Schwartz, S. H., Melech, G., Lehmann, A., Burgess, S., Harris, M., & Owens, V. (2001). Extending the cross-cultural validity of the Theory of Basic Human Values with a different method of measurement. *Journal of Cross-Cultural Psychology*, *32*(5), 519–542. http://doi.org/10.1177/0022022101032005001

Singh, A. S., Zwickle, A., Bruskotter, J. T., & Wilson, R. (2017). The perceived psychological distance of climate change impacts and its influence on support for adaptation policy. *Environmental Science & Policy*, *73*(September 2016), 93–99. http://doi.org/10.1016/j.envsci.2017.04.011

Smith, P. K., & Trope, Y. (2006). You focus on the forest when you're in charge of the trees: Power priming and abstract information processing. *Journal of Personality and Social Psychology*, *90*(4), 578–596. http://doi.org/10.1037/0022-3514.90.4.578

Spence, A., Leygue, C., Bedwell, B., & O'Malley, C. (2014). Engaging with energy reduction: Does a climate change frame have the potential for achieving broader sustainable behaviour? *Journal of Environmental Psychology*, *38*, 17–28. http://doi.org/10.1016/j.jenvp.2013.12.006

Spence, A., & Pidgeon, N. (2010). Framing and communicating climate change: The effects of distance and outcome frame manipulations. *Global Environmental Change*, *20*(4), 656–667. http://doi.org/10.1016/j.gloenvcha.2010.07.002

Steg, L., de Groot, J., Dreijerink, L., Abrahamse, W., & Siero, F. (2011). General antecedents of personal norms, policy acceptability, and intentions: the role of values, worldviews, and environmental concern. *Society and Natural Resources*, *24*(4), 349–367. http://doi.org/10.1017/CBO9781107415324.004

Steg, L., & de Groot, J. I. M. (2012). *Environmental Values*. (S. Clayton, Ed.). New York, NY: Oxford University Press. http://doi.org/10.1093/oxfordhb/9780199733026.013.0005

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. http://doi.org/10.1177/0013916512454730

Steg, L., & Vlek, C. (2009). Encouraging pro-environmental behaviour: An integrative review and research agenda. *Journal of Environmental Psychology*, *29*(3), 309–317. http://doi.org/10.1016/j.jenvp.2008.10.004

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. http://doi.org/10.1016/j.jenvp.2015.05.012

Stephan, E., Liberman, N., & Trope, Y. (2011). The effects of time perspective and level of construal on social distance. *Journal of Experimental Social Psychology*, *47*(2), 397–402. http://doi.org/10.1016/j.jesp.2010.11.001

Stern, P. C. (2000). Toward a coherent theory of environmentally significant behavior. *Journal of Social Issues*, *56*(3), 407–424. http://doi.org/10.1111/0022-4537.00175

Stern, P. C., Dietz, T., Abel, T., Guagnano, G. A., & Kalof, L. (1999). A Value-Belief-Norm Theory of support for social movements: The case of environmentalism. *Human Ecology Review*. Society for Human Ecology. http://doi.org/10.2307/24707060

Tasic, V., Staake, T., Stiefmeier, T., Tiefenbeck, V., Fleisch, E., & Tröster, G. (2012). Self-powered water meter for direct feedback. *Proceedings of 2012 International Conference on the Internet of Things, IOT 2012*, 24–30. http://doi.org/10.1109/IOT.2012.6402300

Team, R. C. (2017). R: A language and environment for statistical computing. Vienna, Austria: R Foundation for Statistical Computing. Retrieved from https://www.r-project.org/

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. http://doi.org/10.1016/j.buildenv.2015.04.009

Thøgersen, J. (1999). Spillover processes in the development of a sustainable consumption pattern. *Journal of Economic Psychology*, *20*, 53–81. Retrieved from https://ac-els-cdn-com.ezproxy.library.wur.nl/S0167487098000439/1-s2.0-S0167487098000439-main.pdf?_tid=a6052a3f-108b-45ba-b9c8-f02f102a6739&acdnat=1523214210_f2e382c04ef3bc3adfd9cae4dfddb387

Thøgersen, J. (2011). Green shopping: For selfish reasons or the common good? *American Behavioral Scientist*, *55*(8), 1052–1076. http://doi.org/10.1177/0002764211407903

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

Thøgersen, J., & Møller, B. (2008). Breaking car use habits: The effectiveness of a free one-month travelcard. *Transportation*, *35*(3), 329–345. http://doi.org/10.1007/s11116-008-9160-1

Thøgersen, J., & Ölander, F. (2003). Spillover of environment-friendly consumer behaviour. *Journal of Environmental Psychology*, *23*(3), 225–236. http://doi.org/10.1016/S0272-4944(03)00018-5

Tiefenbeck, V., Goette, L., Degen, K., & Tasic, V. (2016). Overcoming salience bias: How real-time feedback fosters resource conservation. *Management*, (February 2017). http://doi.org/10.1287/mnsc.2016.2646

Tiefenbeck, V., Staake, T., Roth, K., & Sachs, O. (2013). For better or for worse? Empirical evidence of moral licensing in a behavioral energy conservation campaign. *Energy Policy*, *57*, 160–171. http://doi.org/10.1016/j.enpol.2013.01.021

Trope, Y., & Liberman, N. (2003). Temporal construal. *Psychological Review*, *110*(3), 403–421. http://doi.org/10.1037/0033-295X.110.3.403

Trope, Y., & Liberman, N. (2010). Construal-level theory of psychological distance. *Psychology Review*, *117*(2), 440–463. http://doi.org/10.1037/a0018963

Truelove, H. B., Carrico, A. R., Weber, E. U., Raimi, K. T., & Vandenbergh, M. P. (2014). Positive and negative spillover of pro-environmental behavior: An integrative review and theoretical framework. *Global Environmental Change*, *29*, 127–138. http://doi.org/10.1016/j.gloenvcha.2014.09.004

Vallacher, R. R., & Wegner, D. (1989). Levels of personal agency: Individual variation in action identification. *Journal of Personality and Social*, *57*(4), 660–671. http://doi.org/10.1037/0022-3514.57.4.660

Vallacher, R. R., & Wegner, D. M. (1987). What do people think they're doing? Action identification and human behavior. *Psychological Review*, *94*(1), 3–15. http://doi.org/10.1037/0033-295X.94.1.3

van Dam, Y. K., & van Trijp, H. C. M. (2011). Cognitive and motivational structure of sustainability. *Journal of Economic Psychology*, *32*, 726–741. http://doi.org/10.1016/j.joep.2011.06.002

van Dam, Y. K., & van Trijp, H. C. M. (2016). Interventions to encourage sustainable consumption. *APSTRACT: Applied Studies in Agribusiness and Commerce*, *10*(2–3), 51–58.

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. http://doi.org/10.1016/J.JENVP.2017.07.009

van der Linden, S. (2015). The social-psychological determinants of climate change risk perceptions: Towards a comprehensive model. *Journal of Environmental Psychology*, *41*, 112–124. http://doi.org/10.1016/J.JENVP.2014.11.012

van der Linden, S., Maibach, E., & Leiserowitz, A. (2015). Improving public engagement with climate change: Five "best practice" insights from psychological science. *Perspectives on Psychological Science: A Journal of the Association for Psychological Science*, *10*(6), 758–763. http://doi.org/10.1177/1745691615598516

van der Werff, E., Steg, L., & Keizer, K. (2013). The value of environmental self-identity: The relationship between biospheric values, environmental self-identity and environmental preferences, intentions and behaviour. *Journal of Environmental Psychology*, *34*, 55–63. http://doi.org/10.1016/j.jenvp.2012.12.006

van der Werff, E., Steg, L., & Keizer, K. (2014a). Follow the signal: When past pro-environmental actions signal who you are. *Journal of Environmental Psychology*, *40*, 273–282. http://doi.org/10.1016/j.jenvp.2014.07.004

van der Werff, E., Steg, L., & Keizer, K. (2014b). 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. http://doi.org/10.1177/0013916512475209

van Houwelingen, J. H., & van Raaij, W. F. (1989). The effect of goal-setting and daily electronic feedback on in-home energy use. *Source Journal of Consumer Research*, *16*(1), 98–105. Retrieved from http://www.jstor.org/stable/2489305

Venhoeven, L., Bolderdijk, J., & Steg, L. (2013). Explaining the paradox: How pro-environmental behaviour can both thwart and foster well-being. *Sustainability*, *5*(4), 1372–1386. http://doi.org/10.3390/su5041372

Verplanken, B. (2006). Beyond frequency: Habit as mental construct. *British Journal of Social Psychology*, *45*(3), 639–656. http://doi.org/10.1348/014466605X49122

Verplanken, B., & Holland, R. W. (2002). Motivated decision making: effects of activation and self-centrality of values on choices and behavior. *Journal of Personality and Social Psychology*, *82*(3), 434–447. http://doi.org/10.1037/0022-3514.82.3.434

Verplanken, B., & Roy, D. (2016). Empowering interventions to promote sustainable lifestyles: Testing the habit discontinuity hypothesis in a field experiment. *Journal of Environmental Psychology*, *45*, 127–134. http://doi.org/10.1016/j.jenvp.2015.11.008

Verplanken, B., Walker, I., Davis, A., & Jurasek, M. (2008). Context change and travel mode choice: Combining the habit discontinuity and self-activation hypotheses. *Journal of Environmental Psychology*, *28*(2), 121–127. http://doi.org/10.1016/j.jenvp.2007.10.005

Vohs, K. D., Mead, N. L., & Goode, M. R. (2006). The psychological consequences of money. *Science*, *314*(5802), 1154–1156. http://doi.org/10.1126/science.1132491

Wakslak, C., Liberman, N., & Trope, Y. (2007). Construal levels and psychological distance: Effects on representation, prediction, evaluation, and behavior. *Journal of Consumer Psychology*, *17*(2), 83–95. http://doi.org/10.1016/S1057-7408(07)70013-X.Construal

Wakslak, C., & Trope, Y. (2009). The effect of construal level on subjective probability estimates. *Psychological Science*, *20*(1), 52–58. http://doi.org/10.1111/j.1467-9280.2008.02250.x

Webb, T. L., Benn, Y., & Chang, B. P. I. (2014). Antecedents and consequences of monitoring domestic electricity consumption. http://doi.org/10.1016/j.jenvp.2014.07.001

Webb, T. L., & Sheeran, P. (2006). Does changing behavioral intentions engender behavior change? A meta-analysis of the experimental evidence. *Psychological Bulletin*, *132*(2), 249–268. http://doi.org/10.1037/0033-2909.132.2.249

White, A. E., Johnson, K. A., & Kwan, V. S. Y. (2014). Four ways to infect me: Spatial, temporal, social, and probability distance influence evaluations of disease threat. *Social Cognition*, *32*(3), 239–255. http://doi.org/10.1521/soco.2014.32.3.239

White, K., MacDonnell, R., & Dahl, D. W. (2011). It's the mind-set that matters: The role of construal level and message framing in influencing consumer efficacy and conservation behaviors. *Journal of Marketing Research*, *48*(3), 472–485. http://doi.org/10.1509/jmkr.48.3.472

Willis, R. M., Stewart, R. A., Panuwatwanich, K., Jones, S., & Kyriakides, A. (2010). Alarming visual display monitors affecting shower end use water and energy conservation in Australian residential households. *Resources, Conservation and Recycling*, *54*(12), 1117–1127. http://doi.org/10.1016/J.RESCONREC.2010.03.004

Wilson, C., & Dowlatabadi, H. (2007). Models of decision making and residential energy use. *Annual Review of Environment and Resources*, *32*(1), 169–203. http://doi.org/10.1146/annurev.energy.32.053006.141137

Wood, W., & Neal, D. T. (2007). A new look at habits and the habit–goal interface. *Psychological Review*, *114*(4), 843–863. http://doi.org/10.1037/0033-295X.114.4.843

Zelezny, L. C., Chua, P.-P., & Aldrich, C. (2000). Elaborating on gender differences in environmentalism. *Journal of Social Issues*, *56*(3), 443–457. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.472.3559&rep=rep1&type=pdf

Summaries

English summary

Nederlandse samenvatting

English summary

Human behavior has been a critical contributor to CO_2 emissions and environmental degradation in general. Individual energy use behavior has a large impact on total CO_2 emissions, and individual change is therefore needed to reduce the negative impact humans have on the environment. Even though much of previous research has focused on residential energy use, people spend a great portion of their time outside their homes. For example, people go to work, go on holidays or live in temporary housing. Across these situations people are still the end users of energy, but these situations differ in one fundamental way from the household setting: people do not pay the energy bill. As personal financial benefits are naturally lacking across these situations it is important to look at alternative ways to influence behavior. Moreover, financial incentives have proven to be relatively ineffective for stimulating day-to-day changes in individual energy use, which stresses the need for other approaches. In this dissertation we, therefore, specifically focus on energy use behavior in situations in which people do not pay the bill and we test the effectiveness of different intervention methods. To classify intervention approaches we use construal level theory as a general framework. Construal level theory (Liberman & Trope, 1998) poses that people can process information at different levels of abstraction: at a low construal level, which is more concrete and direct, or at a high construal level, which is rather abstract and distant. The level of construal at which people think in turn influences how people make decisions and behave. Manipulating the construal level of different intervention approaches allows us to test what type of approach is best suited for stimulating energy saving behavior across different out-of-home situations.

In **Chapter 1,** we elaborate upon the scope and aims of the dissertation. We discuss different factors that influence current energy use behavior and explain the distinction between curtailment behavior (i.e., changing one's day-to-day behavior) and investment behavior (i.e., buying energy-efficient appliances). Investment decisions have been suggested to be more impactful in terms of potential energy reductions. Yet, in reality, the projected energy savings are often not attained after the investment is made, which suggests that people change their day-to-day behavior. Additionally, in out-of-home situations people often do not have the opportunity to invest in energy efficiency measures and we therefore focus on curtailment behavior. In order to understand how this day-to-day energy use behavior can be effectively changed, we considered three factors to be of importance: the influence of biospheric values, the effectiveness of combined intervention approaches and the net environmental impact. Using construal level theory as the general framework enabled us to make predictions about these three factors. First, in terms of the influence of

values, high construal level thinking will likely facilitate people to act upon their values, whereas values are less influential when thinking at a low construal level. Secondly, in terms of the effectiveness of combined approaches, we argue that congruent combinations (i.e., at the same construal level) are more effective than incongruent combinations, as the information will be processed more efficiently. Thirdly, we considered the net environmental impact to be important, which means that the effectiveness of an intervention should not be solely based on the short-term effect on a target behavior, but should also take long-term and spillover effects into account. We argue that short-term effects can be driven by both low and high construal level interventions, but the overall net environmental impact of interventions is most likely facilitated by high construal level thinking. To test the effectiveness of construal level manipulations, we ran different laboratory and field studies.

Before we specifically tested the direct effect of construal level manipulations on day-to-day energy saving behavior, we first assessed the influence of investments in energy efficiency measures on curtailment behavior in **Chapter 2**. As people are usually unable to make investments in out-of-home situations, we manipulated whether people invested themselves or whether someone else invested for them. Additionally, we manipulated the reason for the investment, by highlighting either the environmental or financial benefits. As environmental problems are often regarded as distant and abstract issues that mostly concern other people, campaigns often highlight benefits that are more personally relevant, such as the financial benefits. Our results suggest that the use of an environmental frame has positive effects on curtailment behavior, both when the investment was made personally or when someone else invested in the energy-efficient light bulb. Focusing on the financial benefits of energy reductions proved to be less effective. Particularly, when someone else had invested for monetary reasons, participants engaged in less curtailment behavior as compared to the other conditions.

Based on our results from Chapter 2, we aimed to assess the direct effect of message framing on curtailment behavior and wanted to contrast messages that highlighted more personal benefits and messages that highlighted the environmental benefits. As out-of-home situations lack the financial benefit component, we appealed to the more immediate health benefits associated with water use. In **Chapter 3,** we argue that appeals to health and environmental benefits can be categorized based on one psychological distance dimension: social distance. Construal level theory poses that the larger the psychological distance, the more abstractly people perceive the information to be. Therefore, we expected that large social distance would lead to high

construal level thinking and small social distance to low construal level thinking. Across two studies (i.e., an online survey and a field study) we tested how people respond to messages on changing shower behavior at a hotel that highlight either health benefits (small social distance), environmental benefits (large social distance), or both benefits at the same time (i.e., incongruent combination). Our results indicate that self-reported intentions were improved by the three experimental messages (Study 1), but it did not result in the desired behavior change when water use was measured objectively in a hotel setting (Study 2). However, how much participants valued the environment did moderate the relation between the messages and actual water use; participants who did not value the environment very much were affected most by appeals that included health benefits (i.e., low social distance). These findings indicate that in a hotel setting, people who do not highly value the environment can be motivated to change their behavior, and behavior change is most likely when low construal level (i.e., health) benefits are highlighted.

The results from Chapter 3 indicated that the combined message was not more effective than the single messages. However, as previous research indicates that combinations have the potential to be more effective, we wanted to systematically test different combinations of construal level manipulations. In **Chapter 4** we therefore tested the effectiveness of construal level combinations on objectively measured individual energy use in an applied setting (e.g., student housing facility). We expected that the congruent combinations (i.e., at the same construal level) would be most effective in realizing a reduction in warm water use. Participants were randomly assigned to a construal level manipulation (low vs. high) in combination with a social distance manipulation (low vs. high) or to the control condition. Our findings suggest that a congruent combination at a high construal level (i.e., the high construal level condition combined with the high social distance condition) has the largest effect on warm water use and that spillover to electricity use is most likely to occur when a high construal level is used (i.e., high social distance). Moreover, especially participants who scored lower on biospheric values were most strongly influenced by the combination of two high construal level approaches. The latter finding is in contrast to Chapter 3, which we argue is driven by the type of situation in which the participants were asked to change their behavior. In Chapter 3 participants were in a short-term situation (i.e., 1-night stay at a hotel), whereas participants in Chapter 4 were staying in their student room for a longer time period (i.e., one year). We argue that the construal level manipulation which is aligned with the type of situation (i.e., low construal with short-term situation and high construal with long-term situation) has the potential to be most effective.

The effectiveness of the manipulations in Chapter 4 turned out to be rather short lived, as the effect dissipated after one week. The main aim of **Chapter 5** was, therefore, to study the longer-term effect of a construal level manipulation. In a field experiment, we investigated whether a construal level manipulation in combination with receiving real-time feedback about (warm) water use in the shower for one month had lasting effects on objectively measured individual energy-use behavior. Our findings indicate that participants in both construal level conditions reduced their water use significantly when receiving real-time feedback. After one month, we uninstalled the real-time feedback device and found that all participants used significantly less water as compared to the baseline period in the month thereafter. Moreover, participants in the high construal level condition who scored high on biospheric values used less water in the period after the feedback device was taken away as compared to those in the low construal level condition. Similar to Chapter 4, the high construal level manipulation was most effective, but this time for those who actually valued the environment more. Similar to Chapters 3 and 4, we suggest that this is due to the type of situation, but also argue that the longer-term nature of the behavior change plays a role in the effectiveness of different types of intervention approaches.

In **Chapter 6**, the general discussion, the main findings from the four empirical chapters are synthesized. From the outset we were particularly interested in the effect of biospheric values on behavior, the effectiveness of combined intervention approaches and the net environmental impact. We discuss our findings in terms of short-term impact, long-term impact and the observed spillover effects. By using different research methods, we argue that the current findings add to construal level theory and practically to the design of effective interventions. Specifically, the laboratory and survey studies (Chapters 2 and 3) allowed us to have a controlled setting, whereas the field studies provided us with more insights into actual behavior change (Chapters 3, 4 and 5). Taken together, our results indicate that congruent combinations should be preferred over incongruent combinations of construal level manipulations. In terms of choosing low or high construal level manipulations, our results suggest that both approaches can be effective, but highlight that it is important to take environmental values and the type of situation into account. Even though most people do not act upon their values in their day-to-day lives, people scoring lower on biospheric values changed their behavior more when we measured short-term behavior change. Moreover, whether a high or low construal level manipulation was most effective depended on the type of situation in which people were. During a short hotel visit, a low construal level message seemed more effective, whereas a longer-term

stay in a student room was more aligned with a high construal level approach. When measuring longer-term change (Chapter 5) or specifically targeting spillover (e.g., Chapter 2), a high construal level approach seemed more promising and the most long-lasting effects were reserved to those who valued the environment more (Chapter 5). We further reflect upon the use of construal level theory as a general framework and discuss some issues and alternative explanations of the current findings. Finally, we provide some clear practical implications for researchers and policymakers.

In conclusion, findings from this research add to our current understanding of energy use behavior, particularly in situations in which people do not pay the bill. Using construal level theory as a general framework increased our understanding of the effect of interventions targeted at behavior change. Our findings show that when designing interventions, a number of factors should be considered. As such, we show that it is important to consider the type of situation (e.g., a short-term hotel visit is better aligned with a low construal level), how much people value the environment (e.g., is there still room for improvement?) and whether spillover effects are desirable (e.g., high construal level thinking facilitates more positive spillover). Ultimately, findings from this dissertation can be used to understand what kind of methods have the most long-lasting effect across multiple energy-related and pro-environmental behaviors.

Nederlandse samenvatting

Menselijk gedrag heeft in belangrijke mate bijgedragen aan de totale CO_2-uitstoot en de achteruitgang van het milieu in het algemeen. Individueel energieverbruik heeft een grote impact op de totale CO_2-uitstoot en individuele verandering is daarom nodig om de negatieve invloed van de mens op het milieu te verminderen. Hoewel veel van voorgaand onderzoek zich gericht heeft op energieverbruik binnen huishoudens spenderen mensen een groot deel van hun tijd buitenshuis. Mensen gaan bijvoorbeeld naar werk, gaan op vakantie of wonen ergens tijdelijk. In dit soort situaties zijn deze mensen nog steeds de eindgebruiker van energie, maar er is één fundamenteel verschil met de situatie binnen huishoudens: mensen betalen de energierekening niet. Aangezien persoonlijke financiële voordelen natuurlijkerwijs afwezig zijn in dit soort situaties, is het belangrijk om te kijken naar andere manieren om gedrag te beïnvloeden. Daarnaast heeft voorgaand onderzoek aangetoond dat financiële prikkels relatief ineffectief zijn gebleken om dagelijks energieverbruik te veranderen, wat wederom de noodzaak voor alternatieve aanpakken onderstreept. In dit proefschrift hebben we ons daarom specifiek toegespitst op situaties waarbij de rekening niet door mensen zelf betaald hoeft te worden en testen we de effectiviteit van verschillende interventiemethodes. Om verschillende interventiemethodes te classificeren hebben we 'Construal Level Theory' gebruikt als een algemeen theoretisch kader. 'Construal Level Theory' (Liberman & Trope, 1998) poneert dat mensen informatie verwerken op verschillende abstractieniveaus: op een laag abstractieniveau, wat concreter en directer is, of op een hoog abstractieniveau, wat abstracter en verder van mensen afstaat. Het abstractieniveau waarop mensen denken beïnvloedt hoe mensen beslissingen nemen en zich gedragen. Het manipuleren van de abstractieniveaus van verschillende interventiemethodes geeft ons de mogelijkheid om te testen welke aanpak het best past bij het stimuleren van energiebesparingsgedrag in verschillende situaties buitenshuis.

In **Hoofdstuk 1** gaan we dieper in op de focus en doelen van dit proefschrift. We bespreken verschillende factoren die invloed hebben op huidig energieverbruik en leggen het verschil tussen inperkingsgedrag (d.w.z. het veranderen van dagelijks gedrag) en investeringsgedrag (d.w.z. het kopen van energie-efficiënte apparatuur) uit. Er wordt veelal gesuggereerd dat investeringsbeslissingen effectiever zijn in termen van potentiële energiebesparing. In werkelijkheid worden de beoogde energiebesparingen echter vaak niet gehaald nadat een investering is gemaakt, wat suggereert dat mensen hun dagelijkse gedrag aanpassen. Bovendien zijn mensen buitenshuis vaak niet in staat om investeringen in energie-efficiënte maatregelen te doen en we richten ons daarom voornamelijk op inperkingsgedrag. Om te begrijpen hoe dagelijks energieverbruik op

een effectieve manier veranderd kan worden, hebben we de invloed van drie factoren mee laten wegen: de invloed van milieubewuste (ofwel biosferische) waarden, de effectiviteit van gecombineerde interventiemethodes en het netto milieueffect. Door 'Construal Level Theory' als algemeen theoretisch kader te gebruiken heeft ons in staat gesteld om voorspellingen te doen over deze drie factoren. Ten eerste, wat betreft de invloed van biosferische waarden, verwachten we dat het denken op een hoger abstractieniveau ertoe leidt dat mensen zich meer in lijn met hun waarden gedragen, terwijl dit soort belangrijke waarden minder invloed op gedrag hebben wanneer ze op een lager abstractieniveau denken. Ten tweede, aangaande de effectiviteit van gecombineerde aanpakken, argumenteren wij dat congruente combinaties (d.w.z. op hetzelfde abstractieniveau) effectiever zijn dan incongruente combinaties, gezien de informatie efficiënter verwerkt kan worden. Ten derde argumenteren wij dat het netto milieueffect belangrijk is om in beschouwing te nemen, wat betekent dat de effectiviteit van een interventie niet alleen gebaseerd moet zijn op het korte-termijn effect op een doelgedrag, maar dat ook de lange termijn en spillover effecten meegewogen moeten worden. Wij redeneren dat de korte termijneffecten gedreven kunnen worden door interventies op zowel een laag als een hoog abstractieniveau, maar dat het netto milieueffect van interventies waarschijnlijk het grootst is wanneer men denkt op een hoger abstractieniveau. Om de effectiviteit van manipulaties op verschillende abstractieniveaus te testen hebben we verschillende lab en veldexperimenten uitgevoerd.

Voordat we specifiek gekeken hebben naar het directe effect van manipulaties op verschillende abstractieniveaus op dagelijks energieverbruik, hebben we eerst de invloed van investeringen in energie-efficiënte maatregelen op inperkingsgedrag getest in **Hoofdstuk 2.** Aangezien mensen over het algemeen niet in staat zijn om investeringen te doen buitenshuis (bijvoorbeeld op werk), hebben we in een experiment mensen ofwel zelf een investering laten doen in een energie-efficiënte lamp of iemand anders voor hen eenzelfde investering laten doen. Daarnaast hadden we ook de reden voor de investering gemanipuleerd, waarbij we ofwel de milieuvoordelen of de financiële voordelen hadden benadrukt. Dit laatste hadden we gemanipuleerd omdat milieuproblemen veelal gezien worden als geïsoleerde en abstracte kwesties en om deze reden benadrukken campagnes vaak voordelen die meer persoonlijk van aard zijn, zoals financiële voordelen. Onze resultaten tonen aan dat het benadrukken van de milieuvoordelen van een investering een positief effect heeft op inperkingsgedrag, zowel wanneer mensen de investering zelf hebben gedaan en wanneer iemand anders heeft geïnvesteerd voor hen. Een nadruk op de financiële voordelen van energievermindering bleek minder succesvol te zijn. Specifiek

betekende dit dat wanneer iemand anders geïnvesteerd had voor geldredenen, deelnemers aan het onderzoek minder geneigd waren om inperkingsgedrag te vertonen ten opzichte van de andere condities.

Gebaseerd op de resultaten uit Hoofdstuk 2, wilden we ook de directe effecten van berichten op inperkingsgedrag onderzoeken, waar we berichten die ofwel persoonlijke voordelen of milieuvoordelen benadrukten met elkaar wilden vergelijken. Aangezien mensen buitenshuis vaak geen financiële voordelen hebben aan het verminderen van hun energieverbruik, hebben we gekeken naar de meer directe gezondheidsvoordelen verbonden aan waterverbruik. In **Hoofdstuk 3** argumenteren we dat gezondheids- en milieuvoordelen gecategoriseerd kunnen worden op basis van één psychologische afstandsdimensie: sociale afstand. 'Construal Level Theory' poneert dat hoe groter de psychologische afstand is, hoe abstracter mensen de informatie beschouwen. Wij verwachtten daarom dat grotere sociale afstand leidt tot het denken op een hoger abstractieniveau en kleinere sociale afstand tot het denken op een lager abstractieniveau. In twee studies (een online vragenlijst en een veldexperiment) hebben we getest hoe mensen reageerden op berichten gericht op het veranderen van hun douchegedrag in een hotel welke ofwel de gezondheidsvoordelen (kleine sociale afstand), de milieuvoordelen (grote sociale afstand), of beide voordelen op hetzelfde moment (d.w.z. een incongruente combinatie) benadrukten. Onze resultaten geven aan dat, door de drie experimentele berichten, de zelf-gerapporteerde intenties bij mensen hoger waren ten opzichte van de controleconditie (Studie 1), maar dat dit niet leidde tot de gewenste gedragsverandering wanneer waterverbruik objectief gemeten werd in een hotel (Studie 2). Desalniettemin, hoe belangrijk deelnemers het milieu vonden had een modererende invloed op de relatie tussen de berichten en het daadwerkelijke waterverbruik; deelnemers die het milieu niet erg belangrijk achtten werden het meest beïnvloed door de berichten waar de gezondheidsvoordelen werden benoemd (d.w.z. lage sociale afstand). Deze bevindingen geven aan dat mensen in een hotelsituatie die het milieu niet erg belangrijk vinden gemotiveerd kunnen raken om hun gedrag te veranderen wanneer voordelen op een laag abstractieniveau worden benadrukt.

De resultaten van Hoofdstuk 3 gaven ook aan dat het gecombineerde bericht niet efficiënter was dan de berichten die slechts één voordeel benadrukten. Echter, aangezien voorgaand onderzoek aantoont dat combinaties de potentie hebben om efficiënter te zijn, wilden we systematisch verschillende combinaties testen waar we het abstractieniveau manipuleerden. In **Hoofdstuk 4** hebben we daarom de effectiviteit van combinaties, waarbij we verschillende abstractieniveaus hebben gemanipuleerd, op objectief gemeten individueel energieverbruik in een toegepaste

setting (bijv. een studentenhuisvestingsfaciliteit) getest. We verwachtten dat de congruente combinatie (d.w.z. op hetzelfde abstractieniveau) het meest effectief zou zijn in het realiseren van een reductie in warm waterverbruik. Deelnemers werden willekeurig toegewezen tot een manipulatie van het abstractieniveau (laag vs. hoog) in combinatie met een manipulatie van de sociale afstand (laag versus hoog) of tot de controleconditie. Onze bevindingen suggereren dat een congruente combinatie op een hoog abstractieniveau (d.w.z. een hoog abstractieniveau gecombineerd met de grote sociale afstandsconditie) het grootste effect had op warm waterverbruik. We hebben daarnaast ook gekeken naar het effect op elektriciteitsverbruik (het zogeheten spillover gedrag) en vinden positieve spillover naar elektriciteitsverbruik wanneer een hoog abstractieniveau was gemanipuleerd (d.w.z. grote sociale afstand). Verder tonen onze resultaten aan dat mensen die het milieu minder belangrijk vonden het meest beïnvloed werden door de combinatie van twee manipulaties op een hoog abstractieniveau. De laatstgenoemde bevinding is in tegenstelling tot de bevindingen in Hoofdstuk 3, welke we toeschrijven aan de tijdsduur van de situatie in welke deelnemers gevraagd worden om hun gedrag te veranderen. In Hoofdstuk 3 zaten deelnemers in een korte-termijn situatie (één nacht in een hotel), terwijl deelnemers in Hoofdstuk 4 voor een langere tijd in hun studentenkamer verbleven (één jaar). We argumenteren dat de manipulatie van het abstractieniveau welke in lijn staat met de tijdsduur van de situatie (d.w.z. een laag abstractieniveau met een korte-termijn situatie en een hoog abstractieniveau met een lange-termijn situatie) de potentie heeft om het meest effectief te zijn.

De effectiviteit van de manipulaties in Hoofdstuk 4 bleken relatief van korte duur, aangezien het effect na één week verdwenen was. Het voornaamste doel van **Hoofdstuk 5** was daarom het bestuderen van de langere-termijn effecten van manipulaties van het abstractieniveau. In een veldexperiment hebben we getest of manipulaties van abstractieniveau in combinatie met het verkrijgen van real-time feedback over (warm) waterverbruik in de douche voor één maand een blijvend effect heeft op objectief gemeten individueel energieverbruik. Onze resultaten tonen aan dat deelnemers in beide condities (d.w.z. zowel op een laag als hoog abstractieniveau) hun waterverbruik significant verminderen wanneer ze real-time feedback verkregen. Na één maand hebben we het apparaat welke de real-time feedback verschafte weer weggehaald en zagen we dat alle deelnemers een maand later nog steeds significant minder water verbruikten ten opzichte van het waterverbruik in de baseline periode. Bovendien, wanneer deelnemers gevraagd werden om op een hoog abstractieniveau te denken over hun waterverbruik én hoger scoorden op biosferische waarden (d.w.z., mensen die het milieu belangrijker vonden) verbruikten zij minder water in de periode

nadat het feedbackapparaat weggehaald was ten opzichte van deelnemers die gevraagd werden om op een laag abstractieniveau te denken. In lijn met Hoofdstuk 4 geven deze resultaten weer dat het denken op een hoger abstractieniveau het meest effectief was, maar dit keer wel voor degenen die het milieu belangrijker vonden. Vergelijkbaar met Hoofdstukken 3 en 4, suggereren wij dat dit te maken heeft met de tijdsduur van de situatie, maar argumenteren ook dat het bewerkstelligen van gedragsverandering op de lange termijn beïnvloed wordt door verschillende soorten interventiemethoden.

In **Hoofdstuk 6**, de algemene discussie, worden de hoofdbevindingen van de vier empirische hoofdstukken samengevat. Vanaf het begin waren we voornamelijk geïnteresseerd in het effect van biosferische waarden op gedrag, de effectiviteit van gecombineerde interventiemethodes en het netto milieueffect. We bespreken onze bevindingen in termen van korte-termijn effecten, lange-termijn impact en de gevonden spillover effecten. Door het gebruik van verschillende onderzoeksmethoden stellen wij dat de huidige bevindingen bijdragen aan voorgaand onderzoek wat gebruik heeft gemaakt van 'Construal Level Theory' en praktisch aan het ontwerp van effectieve interventies. Met name de laboratorium- en enquêtestudies (Hoofdstukken 2 en 3) stelden ons in staat om een gecontroleerde omgeving te creëren, terwijl de veldstudies ons meer inzicht gaven in de feitelijke gedragsverandering (Hoofdstukken 3, 4 en 5). Alles bij elkaar geven onze resultaten aan dat congruente combinaties de voorkeur verdienen boven incongruente combinaties van manipulaties op abstractieniveau. In termen van het kiezen van manipulaties op een laag of hoog abstractieniveau, suggereren onze resultaten dat beide benaderingen effectief kunnen zijn, maar benadrukken dat het belangrijk is om rekening te houden met milieuwaarden en de tijdsduur van de situatie. Hoewel de meeste mensen niet handelen naar hun waarden in hun dagelijks leven, veranderden mensen die lager scoorden op biosferische waarden hun gedrag meer wanneer we gedragsverandering op de korte termijn hadden gemeten. Bovendien was de vraag of een manipulatie op een hoog of laag abstractieniveau het meest effectief was afhankelijk van het soort situatie waarin mensen zich bevonden. Tijdens een kort hotelbezoek bleek een boodschap op een laag abstractieniveau meer effect te hebben, terwijl een verblijf op langere termijn in een studentenkamer meer in lijn lag met manipulaties op een hoger abstractieniveau. Bij het meten van verandering op de langere termijn (Hoofdstuk 5) of specifiek gericht op spillover (bijvoorbeeld Hoofdstuk 2) bleken manipulaties op een hoger abstractieniveau het meest veelbelovend en waren de meest langdurige effecten voorbehouden aan degenen die het milieu meer waardeerden (Hoofdstuk 5). We reflecteren verder op het gebruik van 'Construal Level Theory' als een algemeen kader en bespreken enkele kwesties en alternatieve verklaringen voor de huidige

bevindingen. Ten slotte geven we enkele duidelijke praktische implicaties voor zowel onderzoekers als beleidsmakers.

Concluderend, de bevindingen van dit onderzoek dragen bij aan ons huidige inzicht in energieverbruik, met name in situaties waarin mensen de rekening niet betalen. Het gebruik van 'Construal Level Theory' als algemeen kader heeft ons meer inzicht gegeven in de effectiviteit van interventies op gedragsverandering. Onze bevindingen tonen aan dat bij het ontwerpen van interventies een aantal factoren moeten worden overwogen. Als zodanig laten we zien dat het belangrijk is om na te denken over de tijdsduur van de situatie (bijvoorbeeld een kort bezoek aan een hotel is beter afgestemd op een laag abstractieniveau), hoe belangrijk mensen het milieu vinden (is er bijvoorbeeld nog ruimte voor verbetering?) en of spillover-effecten wenselijk zijn (bijv. het denken op een hoger abstractieniveau faciliteert meer positieve spillover). Uiteindelijk kunnen bevindingen uit dit proefschrift gebruikt worden om te begrijpen welke methoden het meest langdurige effect hebben op meerdere energie-gerelateerde en milieuvriendelijke gedragingen.

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Training and supervision plan

Anouk Griffioen
Wageningen School of Social Sciences (WASS)

Completed Training and Supervision Plan

Wageningen School of Social Sciences

Name of the learning activity	Department/Institute	Year	ECTS*
A) Project related competences			
Writing research proposal	WUR	2015	3
ECH-51306 Behavioral & Experimental Economics	WUR	2015	1
Psychology of health and environmental behavior. Categorisation and Evaluation	WASS	2015	0.5
Designing Interventions	RUG	2015	0.5
The Journey, Summer school	Climate-KIC, Delft (NL), Berlin (DE), Wroclaw (PL)	2015	6
Theories in Environmental and Economic Psychology	STEP3, Alghero (IT)	2015	2
Judgement and Decision Making	EADM, Amsterdam (NL)	2016	2
Urban Transitions: Reshaping Urban Districts	Climate-KIC, Amsterdam (NL), Bologna (IT)	2017	4.5
'Saving energy when others pay the bill: Field experiments in student housing and hotels'	BCEP Conference, Groningen (NL)	2015	1
'A construal level theory approach to energy saving behavior: A field experiment'	SABE/IAREP Conference, Wageningen (NL)	2016	1
'Does your health trump our environment? Motivating hotel guests to save water'	WASS PhD day, Wageningen (NL)	2017	1
'Does your health trump the environment? Stimulating water conservation among hotel guests'	ICSD, Taormina (IT)	2017	1
'The how and why of shorter showers: the long-term effects of construal level and real-time feedback on water and energy use'	SJDM, Vancouver (CAN)	2017	1
'Is it a bright idea? The influence of investments in energy efficiency measures on day-to-day behavior'	PhD work-in-progress Brownbag, UBC, Vancouver (CAN)	2017	0.5
B) General research related competences			
Introduction course	WASS	2014	1
Competence Assessment (CA)	WGS	2015	0.3
An introduction to R	KLI	2016	1
C) Career related competences/personal development			
Supervision of BSc and MSc thesis projects	ECH/UEC	2015-2018	2
Lecturer Consumer Decision Making (ECH-31306)	ECH/UEC	2017-2018	2
Visiting PhD student at University of British Columbia	UBC, Vancouver (CAN)	2017	6
Total			**37.3**

*One credit according to ECTS is on average equivalent to 28 hours of study load

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