Private Payment versus Public Praise

Effects of rewards and feedback on energy conservation in the workplace

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Abstract

In this field study, we examined how rewards (monetary versus non-monetary) and feedback (private versus public) can stimulate individual energy conservation in the workplace. We examined main and interaction effects. Employees' computer energy consumption was recorded for thirteen weeks using smart meters that allow for individual and very precise measurement of energy use. After baseline measurements (two weeks), we sent feedback and rewards based on participants' individual energy conservation (three weeks). After we ended our interventions, we continued measurements for eight more weeks to investigate longer term effects. During our intervention, non-monetary rewards worked better than monetary rewards and public feedback worked better than private feedback. After our intervention, non-monetarily rewarded participants continued to conserve more energy than monetarily rewarded participants. Questionnaires revealed that motivation to improve energy conservation was a mediator for the effect of feedback type on energy conservation (publicly rewarded participants conserved more energy because they were more strongly motivated to improve their conservation), and social interaction was, in turn, a mediator for the effect of feedback type on motivation to improve energy conservation (publicly rewarded participants were more strongly motivated to improve because they talked more about it with their colleagues). Although we did not find a true mediator for the effect of reward type on energy conservation, we did find a main effect of reward type on positive emotions: non-monetarily rewarded participants scored higher on pride and satisfaction after receiving their rewards than monetarily rewarded participants.

This study shows that public non-monetary rewards can generate positive behavior changes in contrast to private monetary rewards. Although frequently used in society, this study suggests that private monetary rewards can be counterproductive.

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Introduction

In 1990, the Intergovernmental Panel on Climate Change (IPCC), which was created to assess scientific knowledge of global warming, concluded that there was a broad international consensus that human activity had caused an imbalance in the natural cycle of the greenhouse effect which led to climate change. It is now clear that climate changes will be increasingly manifested in important and tangible ways, such as changes in temperature extremes, decreases in the extent of seasonal snow and ice, and increases in sea level (Karl & Trenberth, 2003). Despite the consensus that many of these problems are rooted in human behaviors and can thus be managed by changing relevant behaviors to reduce their environmental impacts (Steg & Vlek, 2009), it seems difficult to collectively decrease our footprint on earth. Because the only way to decrease environmental problems is by all contributing, world leaders face a very challenging situation characterized by a tension between self-interest (maintaining the status quo) and collective interest (changing behaviors). Among psychologists, such a situation where private and collective interests are at odds is known as a 'commons dilemma' (Hardin, 1968). If many people use a common good to their short term and private interests, in the longer term, the common good is destroyed - a problem for all individuals. The world's rising temperature is a well known example of a commons dilemma. If all economies produce as much carbon dioxide as they want, global warming will increase, change our climate, and destroy our planet. To protect against further degradation, *all* economies have to cooperate. Changes in human behavior are needed because technical efficiency gains, such as energy-efficient appliances and home insulation, tend to be overtaken by consumption growth (Midden, Kaiser, & McCalley, 2007). Moreover, technical innovations imply behavior change as well because individuals need to accept and understand them, buy them, and use them in proper ways (Steg & Vlek, 2009). In the current study, we investigate how to effectively change people's behavior in the environmental domain. We focus on a very common method for changing such behavior: the use of incentives.

Punishments versus rewards

Incentives that are often used to facilitate behavior change are rewards for desired behavior and punishments for undesired behavior. As an example, governmental organizations may provide subsidies to companies that develop pro-

environmental services and pose fines on people who break environmental laws. Although behavior can be controlled through the provision of positive incentives for 'good' behavior and negative incentives for 'bad' behavior, behaviorists have favored the use of rewards over the use of punishments for several reasons. First, behavioral psychologists argue that punishments do not work as well as rewards because punishments may create negative attitudes towards the desired behavior (Lehman & Geller, 2004). Furthermore, there are psychologists who argue that punishments can be risky because they might stimulate alternative behaviors that are less desired than the behavior for which the fine is introduced (Mulder, van Dijk & De Cremer, 2006). As an example, people may drop their trash in the garden of a neighbor to prevent a fine for trash placed too early at the indicated spot. Additionally, these psychologists argue that it is often more difficult to use punishments than rewards; punishments only work well when the chance of being caught is close to 100%, meaning that punishments need more control and monitoring to become effective (Mulder et al., 2006). Punishments are also unpopular because they can be interpreted as unethical or paternalistic, they may create legal problems, and they can cause bad relationships with employees and clients. Therefore, non-governmental and commercial organizations generally prefer using rewards rather than punishments to stimulate desired behavior. For these reasons, this study does not focus on punishments, but on rewards and how they can increase pro-environmental behavior.

The soundest explanation of why rewards are effective is that they provide people with positive consequences that make the desired behavior more attractive than alternative behaviors. However, more explanations exist. For example, rewards are effective because they indicate which behavior is socially desired. In environmental decision-making this is useful because, given the complex processes that are involved with climate change, it is not always clear which behavior is most environmentally friendly (Steg, 2008). Without external indications, people tend to rely on simple heuristics. For example, people think that the amount of energy used by appliances is related to their size. The larger the appliance, the more energy it is believed to use (Baird & Brier, 1981). Obviously, this is not always accurate. Moreover, rewards are effective because they create the expectation that others will cooperate and act pro-socially since people expect that others also want to be rewarded. In this way, rewards can reduce the fear of being the only one who chooses in favor of the common good ('the so-called sucker', see Orbell & Dawes, 1981).

Besides these universal aspects, rewards also have distinct characteristics that make them effective. On the basis of distinct outcome utilities, informative content, and mechanisms through which rewards regulate human action (Bandura, 1997), a distinction can be made between monetary rewards (e.g., money, subsidies or presents) and non-monetary rewards (e.g., performance feedback or social recognition) (Peterson & Luthans, 2006). Although economists might argue that monetary rewards are more effective to stimulate pro-environmental behavior, psychological theories suggest that non-monetary rewards should be favored (e.g., Bowles, 2008; Fehr & Falk, 2002; Frey & Jegen, 2001; Deci, Koestner & Ryan, 1999). Therefore, in this study, we examined which type of reward (monetary or non-monetary) is most effective for stimulating individual pro-environmental behavior. We administered these rewards either in a private or public feedback context to test whether this would strengthen their effects.

Monetary rewards

Monetary rewards deliver direct material advantages to the individual that can be exchanged for other desirable outcomes such as goods, services and privileges. This makes them strong activators of desired behavior (Peterson & Luthans, 2006). As a result, people are attracted to well-paying jobs, extend extra effort to perform the activities that bring them more pay, and become agitated if their pay is threatened or decreased (Stajkovic & Luthans, 2001). However, monetary rewards also have negative side-effects (Bowles, 2008) that may be counterproductive when trying to achieve social goals, such as decreases in energy consumption. As Bowles summarizes, it is often underestimated how much people derive satisfaction from presenting themselves as dignified, autonomous, and moral individuals. This explains why people donate blood, help strangers, and give donations to charitable organizations (Benabou & Tirole, 2006). The experienced satisfaction that motivates people to act pro-socially may be undermined when monetary compensation, which appeals to the self-interest of individuals, is given for such 'moral behavior.' Thus, appealing to self-interest via monetary rewards may crowd out intrinsic motivation to act pro-socially (Deci, Koestner & Ryan, 1999; Frey & Jegen, 2001). This is not the only negative side-effect of emphasizing monetary gains. When a moral decision is proposed as if it is a cost-benefit analysis, the feeling of being responsible for the collective good may decline. This is problematic because people may get the

impression that they can pay (or choose not to be paid) not to cooperate (Fehr & Falk, 2002). Activating a cost-benefit analysis is especially problematic when monetary gains are low, as is often the case with energy conservation. Conserving energy generally concerns relatively small amounts of money. For example, replacing a 60 watt incandescent bulb for a 15 watt compact fluorescent lamp (CFL), also known as an energy saving light, saves about $5.75 dollar per month[1] (U.S. Environmental Protection Agency). People may choose not to act pro-environmentally because they do not consider the incentive to be worthwhile. We argue that these negative aspects do not exist if non-monetary rewards are used. We think non-monetary rewards (vs. monetary rewards) will have a more positive effect on pro-environmental behavior. This expectation is based on goal-framing theory (Lindenberg, 2001) which provides insights into effective ways to strengthen socially relevant behaviors.

Goal-framing theory

The central idea of goal-framing theory is that people have multiple goals that lead them to act: a hedonic goal 'to feel better now,' a material goal[2] 'to guard and improve one's resources,' and a normative goal 'to act appropriately' (Lindenberg, 2001). These goals 'frame' what people attend to, what knowledge and attitudes become cognitively most accessible, how people evaluate various aspects of situations, and what alternatives are considered. Goal-framing theory proposes that although behavior is driven by multiple goals that act together, one goal dominates the framing process. Goal-framing theory postulates that, to stimulate pro-social behavior, a normative goal frame should dominate because a normative goal frame often implies acting pro-socially, whereas material and hedonic goal frames often lead people to act in line with individual interests, which in many cases are not environmentally sound (Lindenberg & Steg, 2007). According to goal-framing theory, a normative goal frame can become dominant by strengthening that frame and/or by making hedonic and material goals compatible with normative goals. This can be complicated because normative goals are easily overshadowed by hedonic and material goals, which are usually more in line with individual interests than normative goals are. Because it is more difficult to strengthen normative aspects than to activate

[1]Assumes the light is on for 3 hours per day and that the electric rate is 11.3 dollar cents per kilowatt-hour. This calculation excludes the initial purchase price and is discounted over the products' lifetime.
[2] We use the term 'material goal frame' instead of the original term 'gain goal frame' to avoid possible confusion with the term 'gain frame' used in prospect-theory.

hedonic or material aspects of behavior, companies often try to stimulate pro-environmental behavior by creating hedonic or material advantages for pro-social behavior. However, according to goal-framing theory, this will only work if the normative reasons for creating these advantages are still emphasized. If the normative reasons for stimulating pro-environmental behavior are not emphasized, hedonic and material goal frames may be the reason why people adopt pro-environmental behaviors. This is risky because the desired behavior choice may depend on mood or on whether the incentive is considered worthwhile. It also carries the risk that crowding-out might occur or that people may revert to their previous behaviors as soon as the incentive ceases to exist. Thus, contrary to what companies often do, goal-framing theory states that incentives should dominantly activate normative aspects because it is ultimately the normative frame that needs to be strengthened, whether directly or by weakening competing hedonic and material goals. Even when the normative behavior is in line with hedonic and material interests, goal-framing theory postulates that it is best to accentuate normative reasons because normative aspects of behavior are relatively stable (e.g., conserving energy will always remain a 'moral' thing to do) whereas monetary and hedonic aspects often are unstable (e.g., energy costs may vary and conserving energy may become less interesting after people have discovered how energy can be conserved). We argue that a normative goal frame can best be strengthened with non-monetary rewards. This type of reward is most closely associated with performance feedback and social recognition (Peterson & Luthans, 2006).

Non-monetary rewards: Performance feedback

Performance feedback provides individuals with task-related information on past performance for the purpose of changing or maintaining performance in specific ways (Kluger & DeNisi, 1996). Feedback motivates through the activation of personal norms, which are feelings of obligation to act in a particular manner in specific situations (Schultz, 1998). When feedback is given, a discrepancy may become clear between the feedback and a personal norm (someone's 'ideal self'), resulting in a motivation to eliminate the feedback-personal norm disparity (Schultz, 1998). For example, feedback about one's carbon footprint may reveal that it is much bigger than one would want, leading to a change in behavior to reduce the footprint and eliminate this discrepancy.

Because feedback provides information about how behavior is related to a certain outcome, feedback can affirm competence or ability (Frey, 1999). Further, because feedback is informative only, it is usually not experienced as controlling of what one should do (Deci, Koestner & Ryan, 1999). Thus, feedback leaves people self-determined in their decision to improve their behavior or not. Perceived competence and a feeling of being self-determined are important factors in establishing intrinsic motivation (Ryan & Deci, 2000). Intrinsic motivation has many advantages—it can persist without further external stimulation and may generalize to other related behaviors, also known as the 'spill-over' effect. Performance feedback has been successful in promoting household energy conservation (Abrahamse, Steg, Vlek & Rothengatter, 2005) and recycling (Schultz, 1998). Especially when it was given frequently and tailored, feedback caused strong and long-lasting results (Abrahamse et al., 2005; Lehman & Geller, 2004).

Non-monetary rewards: Social recognition

Performance feedback may be more effective if it is acknowledged by others, or if praise is given when positive goals are reached. Acknowledgement and praise are examples of types of social recognition that may increase intrinsic motivation when provided in an informational rather than a controlling way (Deci, Koestner & Ryan, 1999). Social recognition communicates an injunctive message, a perception of what is approved or disapproved of within a given culture (Reno, Cialdini & Kallgren, 1993). This may also be adopted as a standard from which people do not want to deviate, partly because social recognition may serve as a predictor of desired future rewards (e.g., by fostering a good reputation). As a result, people will engage in behaviors that receive approval and avoid behaviors that lead to disapproval (Bandura, 1986). While social approval may be valued positively because it sometimes generates future benefits, others believe that most people value social recognition positively (and disapproval negatively) for its own sake (Fehr & Falk, 2002). The provision of social recognition has led to success in behavioral management studies: it led to increased improvements in work performance in the fast-food industry (Peterson & Luthans, 2006) and in an operations division of a credit card company (Stajkovic & Luthans, 2001).

Surprisingly, recognition has rarely been studied in environmental psychology. One exception comes from Schultz, Nolan, Cialdini, Goldstein and Griskevicius

(2007), who provided feedback on household energy conservation. Social recognition was given with a positively valenced emoticon (☺) or a negatively valenced emoticon (☹). People received a positive emoticon if they consumed less than the average consumption in their neighborhood and a negative emoticon if they consumed more than the average consumption of the neighborhood. Households that received a negatively valenced emoticon tried to obtain a positively valenced emoticon and therefore decreased their consumptions; households that received a positively valenced emoticon tried to maintain that emoticon by keeping their consumption levels low. Schultz et al. (2007) argued that these emoticons were effective because they improved people's compliance with what was considered appropriate and increased or maintained people's motivation to conserve.

If people are sensitive to how appropriate their behavior is, their sensitivity to appropriate action may be activated even more strongly if their behavior is made known to relevant others. By providing public feedback, relevant others receive information about each other's behavior. This may yield advantages that are not present when rewards are provided in a private context, as explained below.

Private versus public feedback

People commonly perform good deeds and refrain from selfish behavior because people attach honor to the former and shame to the latter. Performing good deeds may thus bring honor, or at least social recognition within the peer group (Brennan & Pettit, 2004). Social recognition may lead to a favorable status or reputation. Status can make the individual more attractive as a future exchange partner (Hardy & van Vugt, 2006) and yield benefits that would otherwise be unattainable. This idea is attractive to people and may therefore encourage pro-social behavior. Further, public feedback provides people with information that can be helpful in increasing competence, as suggested by Festinger's (1954) 'social comparison theory'.

Social comparison theory

Social comparison theory claims that people have a fundamental desire to evaluate their opinions and abilities and that they strive to have stable, accurate appraisals of themselves (Festinger, 1954). According to Festinger, objective non-social criteria for self-evaluations of ability are hard to come by and, as a consequence, people often compare themselves with others to assess their abilities.

Thus, people use information about others' performances to define their own success. Without such information, individual feedback lacks sufficient meaning (Gaines, Duvall, Webster & Smith, 2005). As Gaines et al. explain: "Most teachers recognize that students are rarely satisfied with simply knowing their score on an exam. Students also want to know the mean and distribution of scores" (p. 374). Public feedback may thus give more meaning to individual scores and a thorough understanding of one's personal score may activate a desire to improve. According to Festinger (1954), people in Western society feel the pressure to continually improve themselves. As a result, most people compare their abilities with those of others who perform slightly better than themselves. That people prefer to compare their results upward has been shown in many studies, most of which were conducted in classroom settings (Dijkstra, Kuyper, van der Werf, Buunk, & van der Zee, 2008). And upward comparison worked: observing others who performed slightly better led to increased performances. Blanton, Buunk, Gibbons, & Kuyper (1999) named three reasons why comparison information can lead to increased performance. First, observing or talking with another person who has proficiency at a task can reveal information about how to improve. Second, seeing another person succeed may increase the motivation to improve because, for instance, it raises individuals' feelings of self-confidence and self-efficacy at a task. Third, knowing how others succeed may lead individuals to set higher personal goals. Thus, public feedback may help improve pro-environmental behavior by giving people one or more models from whom to learn.

These models may not only be of help when feedback is given, but also when the feedback is withheld. A field experiment by Schultz (1998) about the effects of individual versus individual plus group feedback on curbside recycling provides some suggestive evidence for this expectation. Both feedback groups increased recycling, however, the people that also received group feedback (i.e., information about the recycling behavior of their neighbors) continued to increase their behavior from the intervention period to the post-intervention period, whereas behavior change in the individual feedback condition (i.e., information about own recycling behavior only) leveled off. Schultz explained his findings as follows: When feedback was withheld, people that had received comparison information about others' behavior still had a standard against which to compare their behavior, whereas people that received private feedback quickly assumed that they were no longer being watched and reverted to their original behavior patterns. Thus, public feedback can help to

establish and maintain normative behavior after feedback is withheld, thereby producing longer-lasting changes than private feedback.

Descriptive versus injunctive social norms

Despite the advantages of public feedback on the stimulation of pro-environmental behavior, one effect of public feedback may lead to inconsistent results: public feedback communicates what most people did in a particular situation. It provides a descriptive social norm (Cialdini, Reno & Kallgren, 1990), which, in turn, provides evidence as to what will likely be effective - "If everyone is doing it, it must be a sensible thing to do" (Cialdini et al., 1990, p. 1015). Such an assumption offers an information-processing advantage and a decision shortcut when one is choosing how to behave in a given situation (Cialdini, 1988). People measure the appropriateness of their behavior by how far away they are from the norm. Being deviant is being above *or* below the norm. As a result, people that performed the targeted behavior at a rate below the norm will increase this behavior. However, people that performed the targeted behavior at a rate above the norm will likely *decrease* this behavior. This unintended side-effect was found in several studies (e.g. Cialdini et al., 1990).

Luckily, there is a way to overcome this effect. According to the focus theory of normative conduct (Cialdini, Kallgren & Reno, 1991), there is a second type of social norm that has a powerful influence on behavior: the injunctive social norm. Whereas descriptive norms refer to what is commonly done in a situation, injunctive norms refer to perceptions of what is commonly approved or disapproved within a culture (Reno, Cialdini & Kallgren, 1993). Adding an injunctive message - indicating that the desired behavior is approved – has been found to prevent the unintended side-effects of descriptive social norms, as in the experiment by Schultz et al. (2007) where the positively valenced emoticon (☺) and negatively valenced emoticon (☹) served as injunctive messages. Without the positively valenced emoticon providing an injunctive norm, people who consumed less than average would probably have started to increase their consumption. However, the message that their consumption level was approved prevented this effect. Thus, public feedback with an injunctive social message can increase normatively desired behavior. It is likely that this normative intervention can bring recognition and social status within a peer group and also stimulate people to make upward comparisons to increase pro-environmental behavior.

The current study

The current study was conducted in an organizational setting and focused on the energy conservation of employees. Although there has been research on the behavioral and psychological aspects of energy conservation, little of this research has been conducted in organizations (Scherbaum, Popovich & Finlinson, 2008) in spite of the fact that a substantial proportion of a nation's total energy use is consumed in industrial and commercial buildings (35% and 16%, respectively; Kempton, Darley & Stern, 1992). In addition, studies that have addressed energy consumption in the workplace have not focused on rewards and feedback (for exceptions, see Siero, Bakker, Dekker & van den Burg, 1996, and Staats, van Leeuwen, & Wit, 2000), which is surprising given their promise as commonly used intervention strategies in behavioral management and their proven effectiveness in household settings. Therefore, in this study we examined the effects of reward type (monetary vs. non-monetary) and feedback type (private vs. public) on individual energy conservation in the workplace. We predict the following main effects:

Non-monetary rewards will lead to greater energy conservation compared to monetary rewards (hypothesis 1).

Public feedback will lead to greater energy conservation compared to private feedback (hypothesis 2).

As mentioned earlier, public feedback can motivate people to behave pro-socially because it may bring them social status (Brennan & Pettit, 2004). However, public feedback may also signal *why* people were pro-social (e.g., to earn a certain reward). We expect that people can obtain a higher social status when the feedback signals that other-regarding motives were present, than when the feedback signals that self-regarding motives were present. Because non-monetary rewards are more strongly related to other-regarding motives, while monetary rewards are associated more strongly with self-regarding motives, we expect to find an interaction effect between reward type (monetary vs. non-monetary) and feedback type (private vs. public). We predict that our participants will increase their energy conservation behavior more strongly when public feedback is accompanied by non-monetary rewards, than when public feedback is accompanied by monetary rewards. This leads to the following hypothesis:

Feedback type will have a stronger positive effect on energy conservation in combination with non-monetary rewards than in combination with monetary rewards,

such that public feedback will increase the effect of non-monetary rewards more strongly than it increases the effect of monetary rewards (hypothesis 3).

To measure energy conservation we used measurement plugs that continuously recorded energy consumption of connected devices (described in detail below) and a self-report scale that we asked participants to fill out before (pre-test) and after (post-test) the intervention weeks. We expected the effects of our manipulations to be the same on energy conservation as measured by the measurement plugs and as measured by the self-report scale.

The effects of our manipulations on self-reported energy conservation will correspond to the effects recorded by the measurement plugs (hypothesis 4).

For the effect of reward type on energy conservation (hypothesis 1) we expected to find two mediating variables. First, we expected that monetary versus non-monetary rewards would affect energy conservation differently because they would have different effects on the motivation to conserve energy. This prediction is based on the idea that monetary rewards appeal to self-interest (Bowles, 2008), which can be a threat to intrinsic motivation for pro-social behavior (Deci, Koestner & Ryan, 1999; Frey & Jegen, 2001), whereas non-monetary rewards (i.e., feedback) can increase motivation to act pro-socially through the activation of normative standards from which people do not want to deviate. Thus, we expected motivation to conserve to be a mediator for the effects of reward type on energy conservation, such that non-monetary (vs. monetary) rewards would have a stronger positive effect on motivation to conserve, which will lead to greater energy conservation.

The effect of reward type on energy conservation will be mediated by motivation to improve energy conservation, such that non-monetary (vs. monetary) rewards will lead to a higher motivation, which in turn will lead to greater energy conservation (hypothesis 5).

The second mediating variable that we expected to find for the effect of reward type on energy conservation was 'positive emotions' (pride and satisfaction). We expected that non-monetary and monetary rewards affect energy conservation differently because they affect positive emotions in different ways. This is based on the idea that non-monetary rewards can be experienced as more informational and less controlling compared with monetary rewards (Deci, Koestner & Ryan, 1999). Thus, it is likely that non-monetary rewards affirm a feeling of being self-determined and competent to a greater extent than monetary rewards do. We expected that a feeling of

being self-determined and competent would be positively related to levels of satisfaction and pride about one's own behavior. The positive relation of non-monetary rewards and positive emotions is also supported by Fehr and Falk (2002). They argue that social approval makes people feel proud and happy. We therefore predicted that positive emotions would mediate the effect of reward type on energy conservation such that non-monetary (vs. monetary) rewards would lead to stronger positive emotions, resulting in greater energy conservation.

The effect of reward type on energy conservation will be mediated by positive emotions, such that non-monetary (vs. monetary) rewards will lead to higher levels of positive emotions, which in turn will lead to greater energy conservation (hypothesis 6).

For the effect of feedback type on energy conservation (hypothesis 2) we also expected to find two mediating variables. First, we expected that motivation to conserve would be a mediator such that motivation would be higher for people who received public feedback which in turn would lead to greater energy conservation. We expected this because in public feedback conditions people are motivated by the idea that they can obtain a positive social status when others get to know their (pro-social) behavior (Hardy & van Vugt, 2006) while in private feedback conditions this is less likely. Another reason for our hypothesis that motivation mediates the effect of feedback type on energy conservation is the assumption that peoples' natural tendencies to improve themselves are enhanced when they receive public feedback (Festinger, 1954). By providing comparison information, peoples' own behavior is made more salient and meaningful and therefore it is more likely that people will act upon the information. Also, when people learn how others with better scores behaved, it can raise their feelings of self-confidence and self-efficacy (Blanton et al., 1999) which motivates them to improve their behaviors and obtain the same results. These possibilities are not present when feedback is given in a private context. This leads to the following hypothesis:

The effect of feedback type on energy conservation will be mediated by motivation to improve energy conservation, such that public (vs. private) feedback will lead to more motivation, and this in turn will lead to greater energy conservation (hypothesis 7).

The second mediator that we expected to find for the effect of feedback type on energy conservation was social interaction. As discussed above, we predicted that

public feedback would stimulate people to make social comparisons in order to obtain information about how to improve their behaviors. In this process it is likely that they talk to each other about the possible ways to increase their performance. Thus, related to motivation to increase energy conservation, we expected that public (vs. private) feedback would lead to more social interaction about energy conservation, which would positively affect energy conservation.

The effect of feedback type on energy conservation will be mediated by social interaction, such that public (vs. private) feedback will lead to more social interaction, which will lead to greater energy conservation (hypothesis 8).

In addition, we did one exploratory analysis. In general, it may be experienced as more socially desirable to conserve energy for moral reasons (to save the environment) than to conserve energy for material reasons (to save money). Because in our experiment people in monetary reward conditions were not able to demonstrate moral intentions, while people in non-monetary reward conditions were, we performed an exploratory analysis on the relationship between reward type and moral intentions to conserve energy.

Method

Participants

Eighty-four employees of a Dutch company participated in this study. The company delivers projects, products and services for sustainable energy supply. We ran the study at this company because they were testing a new method of measuring and monitoring individual energy consumption (see below for a detail description) that was of special interest to our experiment. When we started the study, the company had installed 84 measurement devices at their employees' computers. Since this setup offered an ideal opportunity for our experiment, we asked (via email or direct request) these employees to participate in a study about energy consumption at the workplace in which their individual energy consumption would be measured. All employees consented.

Final analyses were based on 83 participants (54% male and 46% female), because outlier analysis revealed one participant had an extreme high energy consumption level ($p < .005$). The average age of participants was 36.05 years (SD = 8.55). The mean level of formal education they completed was high: 94.9% of

participants had completed a Bachelor/HBO or Master degree at University. Their average length of employment at the company was two to three years (*SD* = 3.27).

Design

A quasi-experimental design with one control and four experimental conditions was used for this study. Experimental conditions were differently rewarded for the amount of energy they conserved at their computers at work according to a 2 (Reward type: monetary vs. non-monetary) x 2 (Feedback type: private vs. public) factorial design.

After two weeks of baseline measurements and three weeks of interventions, we stopped our feedback and rewards. To investigate the longer-term effects of our manipulations, we measured energy consumption levels for eight more weeks afterwards. In total, this longitudinal field experiment encompassed thirteen weeks of measurements. A digital questionnaire was filled out before and after the intervention period to assess self-reported energy conservation behavior, motivation to improve energy conservation, social interaction about energy conservation, and positive emotions caused by our manipulations. The main dependent variable of this study was energy conservation.

Procedure

Baseline measurement phase (pre-intervention)

During the first two weeks of this study we measured pre-intervention energy consumption levels of every participant to determine their baseline consumption[3]. The algorithms that we used to select the hours of the day that we included in our analyses are described in Appendix 1[4].

After baseline consumption was determined, all participants received an email with a link to our first (online) questionnaire. This five-minute questionnaire assessed socio-demographic factors, computer type used at work, motivation to improve energy conservation, and self-reported energy conservation behaviors. As an incentive for survey completion, we offered participants a report of their own energy

[3] Mean scores were based on 50.45 working hours (*SD* = 18.61) and 248.83 non-working hours (*SD* = 52.17).

[4] It is important to note that we used very conservative estimates of people's energy conservation: When people turned on the stand-by function or turned off their computer during their working day for more than two consecutive hours, we included a maximum of two of these hours in our analysis. We did not include more than two consecutive low-consumption level hours in our analysis because during these hours people might have been engaged elsewhere.

consumption over the period since the measurement device had been installed. After a few reminders, 77 of the 83 participants filled out the pre-test questionnaire.

Intervention phase

Participants were divided into a control group and four experimental groups. The groups were comparable in size: $n_{control} = 16$, $n_{private\ monetary} = 17$, $n_{public\ monetary} = 16$, $n_{private\ non\text{-}monetary} = 16$, and $n_{public\ non\text{-}monetary} = 18$. We could not randomly assign *participants* to conditions. In order to keep participants blind to differences in our manipulations, we assigned participants to condition groups based on workplace location (i.e., different conditions were assigned to different floors or different buildings). However, we did randomly assign *groups* to conditions.

All participants received a report of their average energy consumption levels during baseline measurement.[5] These reports also served as our first manipulation. Except for participants in the control group, all participants were informed that we would send them weekly reports about their energy consumption levels the preceding week and the percentage they had conserved compared to their baseline consumption. We also explained that they would be rewarded for their percentage conserved (see below for a detailed explanation of this manipulation). Participants in the experimental groups received their personal 'Energy Saving Report' every Monday during the three weeks of intervention.

Post-intervention phase

Soon after the last reports were sent, an envelope from the University of Amsterdam was placed on the desks of participants of all experimental groups. The envelope contained a short letter with an overview of their accomplishments and, if applicable, the money they had earned. We underscored the importance of keeping the plug attached to their computers until we collected them. Participants were told this was necessary to properly and securely finish the study. In fact, the main reason was to ensure that we would be able to record the longer-term effects of our interventions.

One week after the last Reports were sent, a second online questionnaire was administered to assess self-reported energy conservation behaviors, experienced motivation to improve energy conservation scores, social interaction about energy conservation scores, positive emotions, and manipulation comprehension levels.

[5] We decided not to exclude participants who did not complete the first questionnaire from further participation in order to avoid reducing the sample size.

Within three weeks, 72 of the 83 participants filled out this questionnaire. After these three weeks, energy consumption levels were recorded for another four more weeks. Immediately after these four weeks, the measurement plugs were collected and participants were debriefed via e-mail.

Materials

Measurement plugs

A recently developed measurement system was used to continuously monitor the electricity use of devices that were connected to measurement plugs placed between the wall outlet and the device's plug (Picture 1). These measurement plugs communicated with each other as well as with the accompanying software. Once the software received data from the plugs, the data was translated into graphs showing kilowatt-hour consumption per hour of all connected devices (for an example, see Appendix 2).

Picture 1. Measurement plug that measures, records and communicates energy consumption of a connected device

Energy saving reports

Energy Saving Reports displayed the amount of energy that a participant consumed during the preceding week and his/her baseline consumption level (in watt-hours per hour). Consumption levels of both working and non-working-hours were included. We also indicated the percentage differences between energy consumption of the previous week and baseline energy consumption. This was followed by the reward contingent on the percentage differences (see Appendix 3 for a description of how percentage differences translated into rewards).

To highlight the reward, which was one of our manipulations, it was presented in a larger font in a textbox colored red to indicate no energy conserved and colored green to indicate energy conserved. Finally, the Report displayed the name of the participant and the number of days and hours the percentage differences were based on. An example Report is shown in Appendix 4.

Reward system

To set up the reward system, we pretested all possible ways of conserving energy and determined what percentage differences an 'average consumer' - someone who sometimes, but not always, uses energy conservation opportunities - could feasibly reach. Our pretesting indicated that a 30% reduction during working hours and a 100% reduction during non-working hours was feasible for average consumers[6]. Our aim was to construct a reward system where it was possible, but not very easy, to earn the highest reward.

Reward type: Monetary versus non-monetary Participants assigned to the monetary reward conditions could earn between 0 and 5.0 Euros per week (~ $7.35 US). Immediately after the three experimental weeks, the money was given in a closed envelope on the desks of the participants.

In the non-monetary reward conditions, people were rewarded with an energy conservation score that varied between 5.0 and 10.0 each week. A comment accompanied each score to explain its meaning. If no energy was conserved, the participant would see a 5.0 with the word "*unfortunately…*" written below. Scores between 5.1 and 5.9 were a "*minor improvement*", between 6.0 and 6.9 were "*okay*", between 7.0 and 7.9 were "*well done*", between 8.0 and 8.9 were "*good*" and, finally, between 9.0 and 10.0 were "*great!*".

To emphasize reward type, participants in the monetary reward conditions were reminded weekly that they could earn 15 Euros in total. Additionally, as often happens in communication about climate change, they were told that by conserving energy they could not only conserve the environment "*but also benefit financially*". Participants in the non-monetary reward conditions were reminded weekly that obtaining a 5.0 meant they had not conserved any energy, which was *"not so good"*, while obtaining a 10.0 meant they had conserved the maximum amount of energy possible, which was "*great!"*

Feedback type: Private versus public To keep feedback private, participants in the private feedback conditions were asked not to discuss their personal Reports with any of their colleagues. As justification we explained that it was important that we recorded the progress of their consumption without the influence of others.

[6] These reductions could be reached by switching the computer to stand-by or hibernate mode for one extra hour per day, turning the monitor off for two extra working-hours per day, lowering the light intensity of the monitor from 100% to 50%, and unplugging the computer during non-working hours.

Participants in the public feedback conditions received a table with the reward they received that week compared to the rewards their colleagues received that week, as shown in Appendix 5. This table preceded their personal energy consumption information in their Reports. To reduce contamination between conditions, participants in the public feedback conditions were asked not to discuss their results with colleagues not mentioned in the table.

Operationalization of energy conservation

Although Reports displayed results of both working- and non-working hours, we restricted our analyses to energy consumption levels during working-hours only. These were much more affected by human behavior and more representative of energy conservation than non-working hours[7]. Because employees were not authorized to install automatically-generated hibernate or stand-by modes, all energy conservation was the result of direct human action.

In our analyses we used percentage conservation during six periods. The first three each represented percentages conservation during one intervention week. The last three represented the percentage conservation of week four (the first post-intervention week), weeks five through seven (the second post-intervention week through the fourth post-intervention week), and weeks eight through eleven (the fifth through eight post-intervention weeks), respectively. This before last period corresponded to completion of the post-intervention questionnaire.

Pre-test questionnaire

Socio-demographic factors Participants provided their name, gender, year of birth, highest level of formal education and length of employment at the current company.

Type of computer used at work Participants indicated what type of computer they used at work (i.e., desktop, laptop, or laptop with a separate (extra) monitor).

Pre-test motivation to improve energy conservation This factor was measured by three items (Cronbach's $\alpha = .87$). An example question is: *"I am willing to change my daily routine to conserve energy."* Participants chose answers on 7-point Likert scales (1 = *strongly disagree* to 7 = *strongly agree*).

[7] Percentage savings during non-working hours were so low (around 0 Wh per hour) that participants either could not conserve energy during these hours or very large positive or negative saving percentages were easily created.

Self-reported energy conservation behaviors Participants were asked to indicate on 7-point Likert scales (1 = *never* to 7 = *always*) to what extent they agreed with four statements about their energy conservation behavior at work. An example of a statement is: *"When I go for lunch, I turn my computer on standby."* Items were combined into a pre-intervention index (Cronbach's $\alpha = 0.56$) and a post-intervention index (Cronbach's $\alpha = 0.65$), reflecting mediocre levels of internal consistency.

Post-test questionnaire

Comprehension checks We investigated participant comprehension of our manipulations with two items: *"Conserving the maximum amount of energy has been 'rewarded' with:"* where participants could choose between seven different answers and *"What is the maximum you earned during this research?"* where participants had to choose from different amounts of Euros or Energy Saving Scores

Motivation to improve energy conservation scores This scale consisted nine items (Cronbach's $\alpha = .91$). An example item is: *"The Energy Saving Reports made me try to conserve more energy."* Items were answered on 7-point Likert scales (1 = *never* to 7 = *always*), except for the item: *"The Energy Saving Reports had no impact on me,"* which had a 7-point Likert scale (1 = *strongly disagree* to 7 = *strongly agree*). This scale was different from the pre-test motivation scale. With the post-test scale we tried to measure the effects of our manipulations on motivation to improve energy conservation scores during the intervention weeks, while the pre-test motivation scale measured readiness to improve energy conservation behavior.

Social interaction about energy conservation scores This was measured by one item: *"I talked about my Energy Saving Scores with a colleague."* Answers were given on a 7-point Likert scale (1 = *never* to 7 = *very often*).

Positive emotions due to our manipulations This was measured by two items ($r = .74$): *"There were moments that the Energy Saving Report made me feel proud."* and *"There were moments that the Energy Saving Report made me feel satisfied."* Participants chose their agreement on 7-point Likert scales (1 = *strongly disagree* to 7 = *strongly agree*).

Moral reason to conserve energy Participants were asked to indicate their agreement with the statement: *"Conserving energy is something that I do because of moral reasons."* Answers were given on a 7-point Likert scale (1 = *strongly disagree* to 7 = *strongly agree*).

Self-reported energy conservation behavior This was the same as in the pre-test questionnaire.

Results

Comprehension checks

Comprehension checks revealed that participants understood the manipulations. Participants in the experimental groups indicated they had read our Reports (M = 5.7, SD = 1.6). They also believed that their Day and Night consumptions, as reported in the weekly Reports, were accurate (M = 5.3, SD = 1.3). Furthermore, participants indicated that they knew whether they had received money or scores for their conservation behavior by correctly answering at least one of the two multiple-choice questions about what they had earned.

Pre-test equivalence of experimental groups

In preliminary analyses, we tested whether experimental groups were equivalent before the intervention. First, a two-way independent ANOVA with reward type and feedback type as factors and absolute pre-intervention energy consumption (in watts per hour) as the dependent variable showed that the non-monetary groups had a higher absolute pre-experimental energy consumption (M = 84.06, SD = 45.33) than the monetary groups (M = 56.75, SD = 31.75), $F(1,63) = 7.82$, $p = .007$. This was likely caused by a difference in the number of desktops versus laptops in these groups: a Pearson's chi-square test with reward type and feedback type as factors and computer type as the dependent variable, revealed a significant difference for reward type, $\chi 2\ (1) = 10.94$, $p = .001$. Participants in the non-monetary groups used more desktops than laptops (23 vs. 11) whereas participants in the monetary groups used more laptops than desktops (24 vs. 9). This difference in the distribution of computers is the most likely explanation for the greater pre-intervention energy consumption in the non-monetary groups versus the monetary groups.

To avoid contrasts due to differences in absolute pre-intervention energy consumption, we used percentage conservation instead of absolute conservation to measure energy conservation. Percentage conservation made energy conservation comparable across conditions and was also easier to interpret. It is important to note that these percentages are purposely conservative (as explained in Appendix 1) in order to only include intentional energy conservation. Because we excluded low-

consumption levels that could not be established as intentional, the actual energy conservation percentages were higher than we report in the results.

To ensure that differences in absolute pre-intervention consumption did not influence percentage conservation, we checked whether absolute pre-intervention consumption was related to any of the conservation percentages that we used as dependent variables. There were no correlations. Additionally, a one-way ANOVA revealed no impact of computer type on overall conservation percentages, $F(1,80) = .93$, $p = .337$. Furthermore, we checked whether the pattern of results differed if we used absolute conservation instead of percentage conservation. This was not the case: the same pattern of results was found. Based on these checks we were convinced that percentage conservation was a valid measure. To completely rule out any influence of absolute pre-intervention consumption on energy conservation, we controlled for this variable in all analyses.

Second, we tested for pre-intervention differences between groups on socio-demographic variables, self-reported energy conservation behavior, and motivation to improve energy conservation behavior. For these analyses we used two-way independent ANOVA's with reward type and feedback type as factors. There were no significant differences between conditions for gender, age, length of employment at the current company, or self-reported energy conservation behavior. However, we did find a significant difference between the monetary and non-monetary conditions for motivation to improve energy conservation, $F(1,58) = 5.31$, $p = .025$. The monetary groups reported a higher motivation to improve ($M = 5.91$, $SD = 0.83$) than the non-monetary groups ($M = 5.38$, $SD = 1.10$). We controlled for motivation to improve energy conservation in our analyses, but it did not have any effects and it was thus excluded from further analyses.

Overall effects

To determine the overall effects of our manipulations, we calculated energy conservation percentages for the six measurement periods for each participant and then averaged these to obtain one mean overall energy conservation percentage per participant. Figure 1 depicts the mean overall conservation percentages for each of the four experimental conditions. The results of a two-way ANOVA with reward type and feedback type as factors confirmed hypotheses 1 and 2. First, as expected, there was a main effect of reward type, such that conservation was greater for participants in the

non-monetary conditions (*M* = 5.63, *SD* = 6.41) than for participants in the monetary conditions (*M* = -0.31, *SD* = 7.93), *F*(1,62) = 10.90, *p* = .002. Second, as expected, there was a (marginal) main effect of feedback type, such as that energy conservation was greater for participants in the public feedback conditions (*M* = 4.28, *SD* = 6.52) than for participants in private feedback conditions (*M* = 1.08, *SD* = 8.64), *F*(1,62) = 3.01, *p* = .088. Contrary to hypothesis 3, the interaction between reward type and feedback type on overall energy conservation percentage was not significant, *F*(1,62) = 0.66, *p* = .420. The size of the feedback type effect for participants that received non-monetary rewards (*M* = 4.79, *SD* = 6.02 vs. *M* = 6.39, *SD* = 6.82), *F*(1,31) = 0.58, *p* = .450, was not greater than the size of the feedback type effect for participants that received monetary rewards (*M* = -2,40, *SD* = 9.42 vs. *M* = 1.91, SD = 5.42), *F*(1,30) = 1.88, *p* = .181.

A post-hoc analysis revealed that, at the group level, there were two significant differences between groups. Conservation due to public non-monetary rewards was greater than conservation due to private monetary rewards (*M* = 6.38, *SD* = 6.82 vs. *M* = -2.40, *SD* = 9.42, *p* = .002). Also, conservation due to private non-monetary rewards was greater than conservation due to private monetary rewards (*M* = 4.79, *SD* = 6.02 vs. *M* = -2.40, *SD* = 9.42, *p* = .021). The mean negative energy conservation percentage in the private monetary group indicates that private monetary rewards were counterproductive. See Table 1 of Appendix 6 for the means and standard deviations at the group level.

Figure 1.

Mean energy conservation (in percentages) over all 11 weeks as a function of reward type (monetary vs. non-monetary) and feedback type (private vs. public).

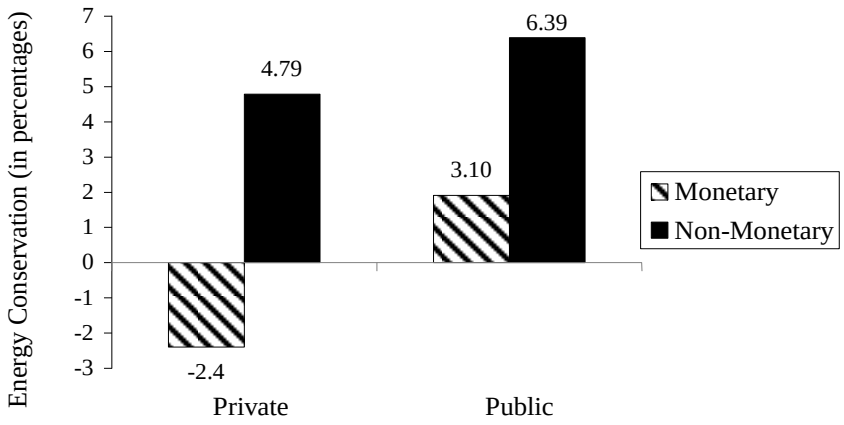
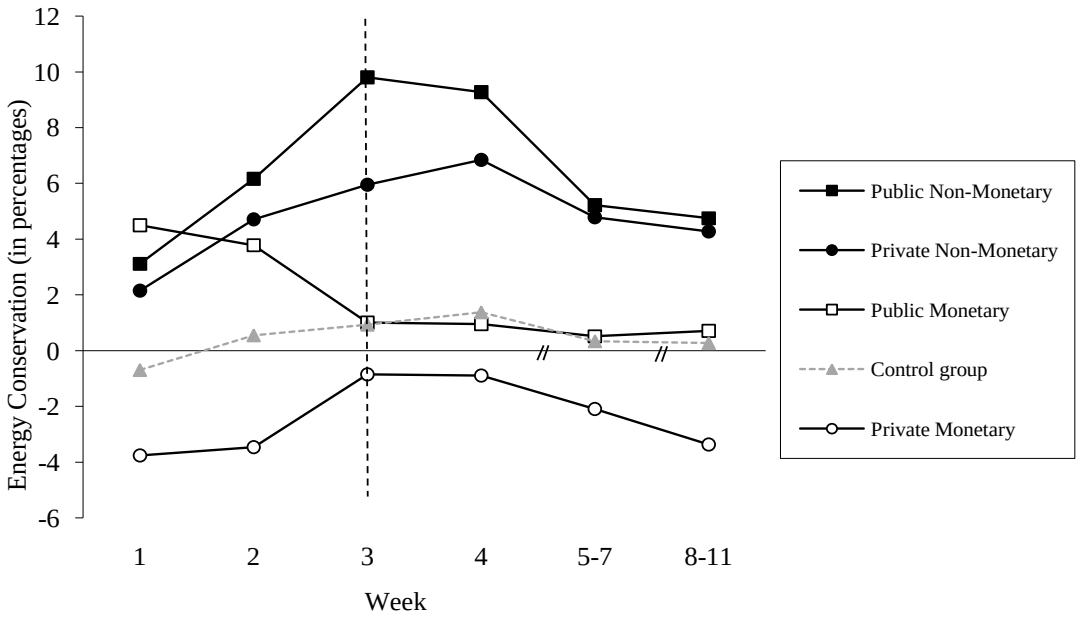


Figure 2 presents the development of the two main effects over time. We added the conservation percentages of the control group in order to conduct a repeated measures ANOVA, with measurements of all six periods inserted as dependent variables. Between-subjects results were the same as the results of the two-way independent ANOVA described above: non-monetary conditions showed a stronger positive energy conservation than monetary conditions, $F(1,62) = 10.90$, $p = .002$. Also, public feedback conditions showed a (marginally significant) stronger positive energy conservation than private feedback conditions, $F(1,62) = 3.01$, $p = .088$.

Figure 2.

Energy Conservation (in percentages) of six measurement periods as a function of reward type (monetary versus non-monetary) and feedback type (private versus public), including control group. The dotted line indicates the end of the intervention period.



As shown in Figure 2, a vertical dotted line is drawn across intervention week 3. This line divides the study in two parts: the intervention weeks (left) and the post-intervention weeks (right). Because we were not only interested in overall effects but also in short versus long-term effects of our interventions, we repeated the analyses described above for the intervention and post-intervention periods separately. The results are given in the following two paragraphs.

Short-term effects

Average of intervention weeks 1-3

To determine the short-term effects of our manipulations, we averaged people's energy conservation percentages for the three intervention weeks into one mean energy conservation percentage per participant. These percentages were the dependent variable in a two-way independent ANOVA with reward type and feedback type as factors. As shown in Figure 3, the results confirmed hypotheses 1 and 2. First, as expected, there was a main effect of reward type on energy conservation, such that conservation was greater for participants in non-monetary reward conditions (M = 5.38, SD = 5.69) than for participants in monetary reward conditions (M = 0.12, SD = 7.98), $F(1,62) = 11.15$, $p = .001$. Second, as expected, there was a main effect of feedback type on energy conservation, such that conservation was greater for participants in public feedback conditions (M = 4.82, SD = 5.45) than for participants in private feedback conditions (M = 0.69, SD = 8.48), $F(1,62) = 6.46$, $p = .014$. There was no interaction effect between reward type and feedback type on energy conservation, $F(1,62) = 1.51$, $p = .224$. Contrary to hypothesis 3, the size of the feedback type effect for participants that received non-monetary rewards (M = 4.27, SD = 5.22 vs. M = 6.36, SD = 6.05) was not greater than the size of the feedback type effect for participants that received monetary rewards (M = -2.69, SD = 9.66 vs. M = 3.10, SD = 4.22.

Figure 3

Mean energy conservation over intervention week 1-3 (in percentages) as a function of reward type (monetary vs. non-monetary) and feedback type (private vs. public).

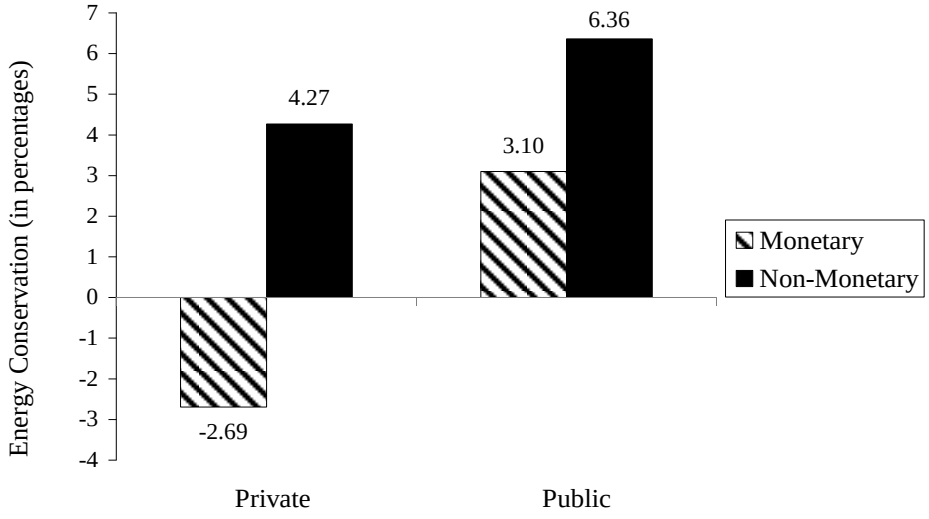
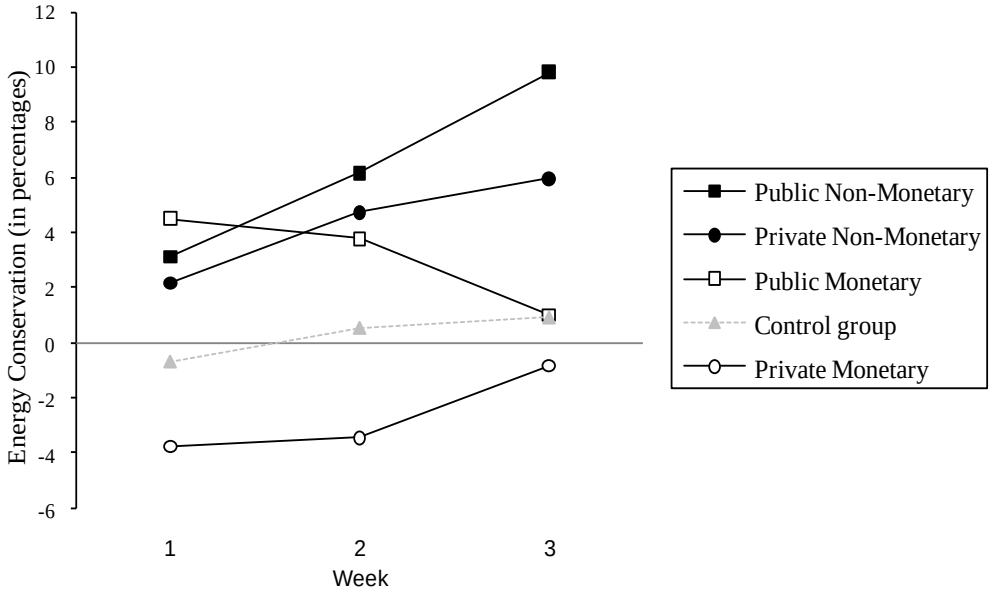


Figure 4 presents the development of the two main effects over time. The conservation percentages of the control group are included for comparison. We conducted a repeated measures ANOVA with reward type and feedback type as factors and the conservation percentages of the three intervention weeks inserted as the dependent variables. Between-subjects results were the same as the results of the two-way independent ANOVA described above: non-monetary reward conditions showed greater energy conservation than monetary reward conditions, $F(1,62) = 11.15$, $p = .001$. Also, public feedback conditions showed greater energy conservation than private feedback conditions, $F(1,62) = 6.46$, $p = .014$.

Figure 4.

Energy conservation (in percentages) of the three intervention weeks as a function of reward type (monetary versus non-monetary) and feedback type (private versus public), including control group.



We also analyzed the effects of our interventions on energy conservation during each intervention week separately because the effects differed across the three weeks.

Intervention week 1

During the first intervention week there was a main effect of feedback type on energy conservation: Public feedback ($M = 3.77$, $SD = 8.37$) led to greater energy conservation compared to private feedback ($M = -0.89$, $SD = 8.44$), $F(1,62) = 5.29$, $p = .025$. Furthermore, there was an interaction effect of reward type and feedback type

during the first intervention week, $F(1,62) = 3.32$, $p = 0.73$: The effect of feedback type was stronger in interaction with monetary rewards than in interaction with non-monetary rewards. The size of the feedback type effect for participants that received monetary rewards ($M = -3.76$, $SD = 8.67$ vs. $M = 4.50$, SD = 7.54), was greater than the size of the feedback type effect for participants that received non-monetary rewards ($M = 2.15$, $SD = 7.26$ vs. $M = 3.12$, $SD = 9.21$). During the first intervention week there was no main effect of reward type on conservation: monetary rewards ($M = 0.25$, $SD = 9.05$) led the same energy conservation as non-monetary rewards ($M = 2.66$, $SD = 8.24$), $F(1,62) = 1.40$, $p = .242$

Intervention weeks 2 and 3

Interestingly, during the second and third intervention weeks, the effect of feedback type on energy conservation declined: During the second intervention week the effect of feedback type on energy conservation was still (marginally) significant, $F(1,62) = 3.85$, $p = .054$. However, during the third intervention week the effect of feedback type on energy conservation was non-significant, $F(1,62) = 1.90$, $p = .173$. The interaction effect of reward type and feedback type also disappeared during the second and third intervention weeks, $F(1,62) = 1.73$, $p = .193$ and $F(1,62) = .10$, $p = .757$, respectively. However, during the second and third intervention weeks a significant main effect of reward type was revealed, $F(1,62) = 5.70$, $p = .020$ and $F(1,62) = 12.92$, $p = .001$, respectively. Means and standard deviations of all energy conservation during the intervention weeks are presented in Table 2, Appendix 6.

Longer-term effects

Post-intervention periods averaged

Energy conservation was recorded for eight weeks after the end of the intervention. As described earlier, these weeks were divided into three periods: the first post-intervention week (week 4), the second until the end-of-the-fourth post-intervention week (weeks 5-7), and the fifth until the end-of-the-eight post-intervention week (weeks 8-11). The energy conservation during the three post-intervention periods was adjusted to one mean conservation percentage per participant to test whether our interventions influenced energy conservation after the intervention had ended, when participants were no longer receiving rewards or feedback. The mean conservation percentages were used as a dependent variable in a two-way independent ANOVA with reward type and feedback type as factors. As shown in

Figure 5, the ANOVA confirmed hypothesis 1: the main effect of reward type persisted in the post-intervention period, such that energy conservation was greater for participants in non-monetary reward conditions (M = 5.89, SD = 8.11) than for participants in monetary reward conditions (M = -0.74, SD = 8.71), $F(1,62) = 8.66$, p = .005. During the post-intervention periods there was no longer an effect of feedback type on energy conservation: conservation was equally strong for participants in public feedback conditions (M = 3.74, SD = 8.38) as for participants in private feedback conditions (M = 1.48, SD = 9.56), $F(1,62) = 0.87$, p = .355. Therefore, we can conclude that non-monetary (vs. monetary) rewards led to greater energy conservation (hypothesis 1) across short and longer-term periods, whereas public (vs. private) feedback led to greater energy conservation (hypothesis 2) for short-term periods only. We will elaborate upon this in the Discussion.

Moreover, there was no interaction effect between reward type and feedback type on post-intervention energy conservation, $F(1,62) = .17$, p = .684: the size of the feedback type effect for participants that received non-monetary rewards (M = 5.30, SD = 7.79 vs. M = 6.41, SD = 8.57), was not greater than for participants that received monetary rewards (M = -2,12, SD = 9.89 vs. M = 0.73, SD = 7.29).

Figure 5

Mean energy conservation (in percentages) over the post-intervention period (weeks 4-6) as a function of reward type (monetary vs. non-monetary) and feedback type (private vs. public).

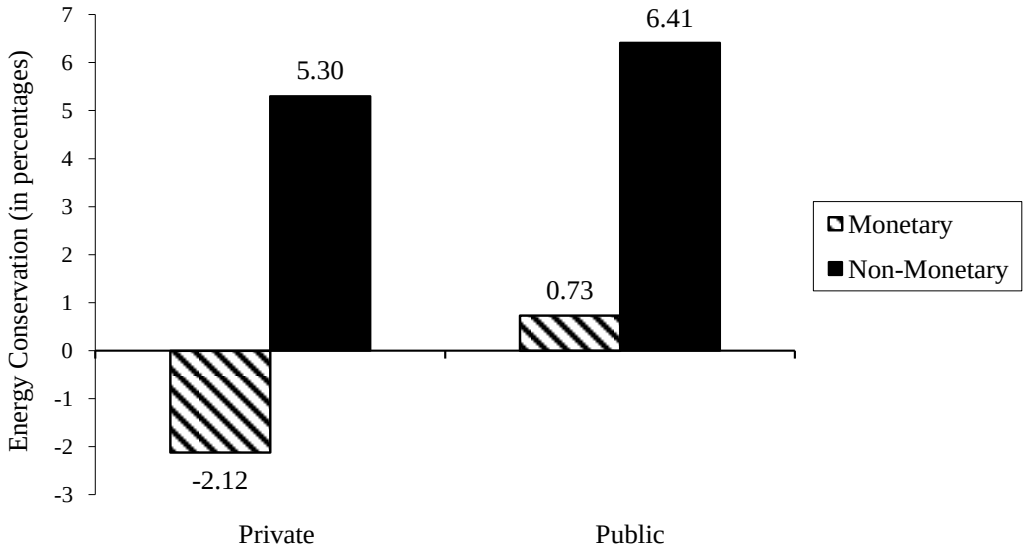
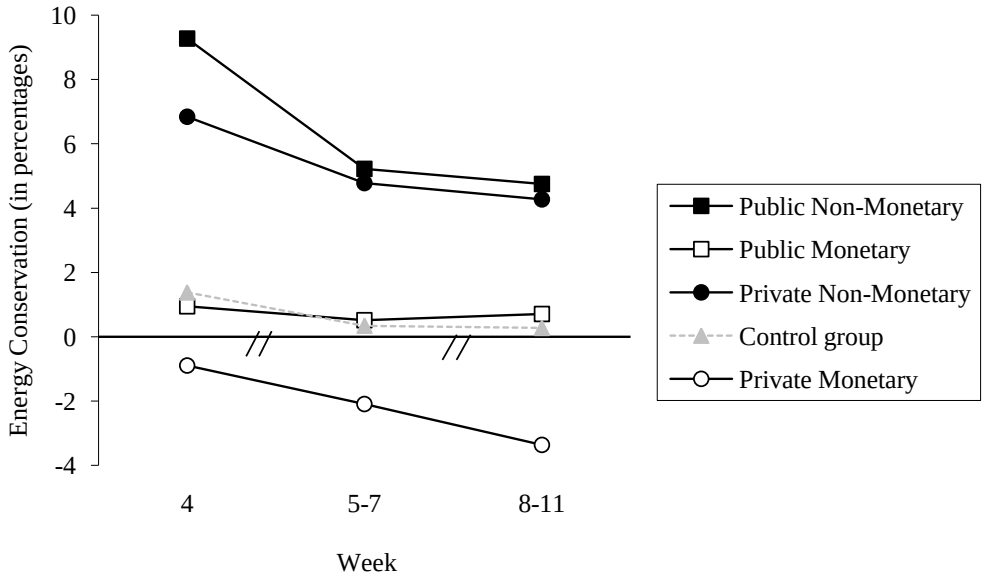


Figure 6 presents the development of energy conservation during the post-

intervention period. The energy conservation percentages of the control group are included for comparison. We ran a repeated measures ANOVA with reward type and feedback type as factors and conservation made during the three post-intervention periods inserted as the dependent variables. Between-subjects results were the same as the results of the two-way independent ANOVA described above: non-monetary reward conditions showed more energy conservation than monetary reward conditions, $F(1,62) = 8.67$, $p = .005$. There was no difference in energy conservation between public and private feedback conditions during post-manipulated periods, $F(1,62) = 0.87$, $p = .355$.

Figure 6

Conservation (in percentages) of the three post-intervention periods as a function of reward type (monetary vs. non-monetary) and feedback type (private vs. public), including control group.



In the last post-intervention period (weeks 8-11), the public non-monetary ($M = 4.75$, $SD = 8.81$) and private non-monetary conditions ($M = 4.27$, $SD = 7.98$) were the only conditions that realized energy conservation that was significantly different from 0 (i.e., baseline levels from the pre-intervention period), $t(17) = 2.29$, $p = .035$ and $t(15) = 2.14$, $p = .049$, respectively.

Pre-test and post-test questionnaires

From the sample of 83 participants, 77 and 72 participants agreed to complete the pre- and post-test questionnaire, respectively. Sixty-eight participants answered both questionnaires. Thus, the overall response rate was 81.9%.

Self-reported energy conservation behaviors

We expected the effects of our manipulations on self-reported energy conservation to correspond to the effects on actual energy conservation (hypothesis 4). Therefore, we carried out a repeated measures ANOVA with reward type and feedback type as factors and the pre- versus post-test mean scores on self-reported energy conservation behaviors as the dependent variables. The means and standard deviations are stated in Table 3 of Appendix 6. Contrary to hypothesis 4, we did not find the same pattern of results for the difference between self-reported conservation pre- and post-test. There were no main effects of reward type or feedback type on the difference between pre- and post-test self-reported energy conservation behaviors, $F(1,54) = .415$, $p = .522$, and $F(1,54) = .348$, $p = .558$ respectively. Participants in all conditions reported an increase in energy conservation from pre- to post-intervention: participants who received non-monetary rewards ($M = 4.60$, $SD = 0.83$ vs. $M = 4.92$, $SD = 0.96$), participants who received monetary rewards ($M = 4.32$, $SD = 1.34$ vs. $M = 4.65$, SD = 1.11), participants who received public feedback ($M = 4.55$, $SD = 1.06$ vs. $M = 4.98$, SD = 0.96), and participants who received private feedback ($M = 4.39$, $SD = 1.16$ vs. $M = 4.60$, $SD = 1.10$.

However, we did find a marginally significant interaction effect of reward type and feedback type on the change between pre- and post-test self-reported energy conservation behavior, $F(1,54) = 3.443$, $p = .069$: Participants who received a public non-monetary reward reported a greater increase in energy conservation ($M = 4.51$, $SD = 0.87$ vs. $M = 5.09$, $SD = 0.90$) than participants who received a public monetary reward ($M = 4.60$, $SD = 1.30$ vs. $M = 4.83$, $SD = 1.05$) whereas participants who received a private non-monetary reward reported a smaller increase in energy conservation ($M = 4.71$, $SD = 0.80$ vs. $M = 4.71$, $SD = 1.03$) than participants who received a private monetary reward ($M = 4.08$, $SD = 1.37$ versus $M = 4.50$, $SD = 1.18$).Thus, public non-monetary rewards had a stronger positive effect on self-reported energy conservation behavior than public monetary rewards, while private non-monetary rewards had a less strong positive effect on self-reported energy conservation behavior than private monetary rewards.

Interestingly, these results did not correspond with the effects of our manipulations on energy conservation as recorded by the measurement plugs: Data from actual measured conservation showed two main effects and no interaction whereas data from self-reported conservation showed an interaction and no main effects. Based on these results hypothesis 4 can be rejected. However, it should be noted that, when all experimental groups are combined, post-test self-reported energy conservation (M = 4.79, SD = 1.04) was higher than pre-test self-reported energy conservation (M = 4.47, SD = 1.10), $t(58) = -2.87$, $p = .006$, which means that participants reported more energy conservation behavior after we sent them feedback and rewards than before we sent them feedback and rewards. Thus, self-report scales confirmed that participants, in general, improved energy conservation behaviors.

Mediating variables

We used the mediation model of Baron and Kenny (1986)[8] for all of our mediation analyses. As a first step, we tested whether the effects of the independent variables on the dependent variable are significant. Therefore we carried out a two-way independent ANOVA with reward type and feedback type as factors and the average energy conservation over the first four weeks (week 1-4) (instead of the first three weeks) as the dependent variable. We used four weeks instead of three because this corresponded to the period during which the post-test questionnaire (which measured our possible mediators, i.e., motivation, social interaction and positive emotions) was completed. The ANOVA showed the following effects: a main effect of reward type and a main effect of feedback type, F (1,62) = 12.86, $p = .001$ and $F(1,62) = 4.64$, $p = .035$, respectively. During the first four weeks, non-monetary reward conditions conserved more energy (M = 6.05, SD = 5.85) than monetary reward conditions (M = 0.05, SD = 7.79), and public feedback conditions conserved more energy (M = 4.91, SD = 5.95) than private feedback conditions (M = 1.23, SD = 8.43). There was no interaction effect of reward type and feedback type on the average energy conservation over the first four weeks, F (1,62) = 0.72, $p = .398$. These results satisfied step one in all mediation analyses reported below.

[8]According to the mediation model of Baron and Kenny (1986), three conditions should be met before a variable can be labeled as a mediator. First, the effect of the independent (manipulated) variable on the dependent variable must be significant. Second, there has to be a significant relation between the independent (manipulated) variable and the possible mediator variable. Third, if a mediation effect exists, the effect of the independent (manipulated) variable on the dependent variable should diminish after addition of the possible mediator variable in the regression analysis.

Motivation to improve energy conservation scores

Motivation to improve energy conservation scores was hypothesized to mediate the effect of reward type on energy conservation (hypothesis 5), and the effect of feedback type on energy conservation (hypothesis 7). Therefore, the effects of reward type and feedback type on motivation to improve energy conservation scores were assessed. This is the second step in the mediation model of Baron and Kenny (1986). To control for possible effects of pre-test motivation to improve energy conservation, we inserted this pre-test factor as a covariate in a two-way independent ANOVA with reward type and feedback type as factors and motivation to improve energy conservation scores as the dependent variable. There was no effect of reward type on motivation to improve energy conservation scores, $F(1,53) = 0.31$, $p = .58$. Monetary reward groups indicated that they were just as motivated to improve energy conservation scores ($M = 4.43$, $SD = 1.02$) as non-monetary reward groups ($M = 4.73$, $SD = 0.98$)[9]. This indicated that motivation to improve energy conservation scores could not be a mediator for the effect of reward type on energy conservation, disconfirming hypothesis 5. However, there was a significant main effect of feedback type, $F(1,53) = 6.18$, $p = .016$. Public feedback groups indicated that they were more strongly motivated to improve their energy conservation scores than private feedback groups ($M = 4.93$, $SD = 1.01$ vs. $M = 4.23$, $SD = 0.87$). Because motivation to improve energy conservation scores was affected by feedback type, we could continue mediation analyses for the relation between feedback type, motivation to improve energy conservation scores, and energy conservation.

If motivation to improve energy conservation scores was a mediator for the effect of feedback type on energy conservation, the effect of feedback type on energy conservation should decrease after correction for the effect of motivation to improve energy conservation scores. For this check, step three in the mediation model of Baron and Kenny was carried out: a multiple regression analysis. Feedback type, reward type, the interaction term Reward Type X Feedback Type, and motivation to improve energy conservation scores were the independent variables, and energy conservation was the dependent variable. The regression analysis showed that the relation of feedback type with energy conservation was no longer significant ($ß = .26$,

[9] Also, there was no interaction-effect of reward type and feedback type on energy conservation, $F(1,53) = .024$, $p = .877$, nor an effect of the covariate pre-test motivation to improve conservation on motivation to improve energy conservation scores, $F(1,53) = .61$, $p = .440$.

p = .15), after correction for the positive and marginally significant relation of motivation to improve energy conservation scores with energy conservation (ß = .25 p = .065).

A Sobel-test revealed that the effect of motivation to improve energy conservation scores on the relation between feedback type and energy conservation, was marginally significant, Z = 1.31, p = .095 (one-tailed). Motivation to improve energy conservation scores was a (partial) mediator for the effect of feedback type on energy conservation[10], confirming hypothesis 7.

Social interaction about energy conservation scores

We hypothesized that social interaction (i.e., talking with a colleague) about energy conservation scores would mediate the effect of feedback type on energy conservation, such that a public (vs. private) feedback type would result in more social interaction, resulting in a stronger increase in energy conservation (hypothesis 8). Therefore, the effects of our manipulations on social interaction about energy conservation scores were assessed (step two in the mediation model of Baron and Kenny, 1986). A two-way independent ANOVA with reward type and feedback type as factors and social interaction about energy conservation scores as the dependent variable revealed a significant main effect of feedback type, F(1,57) = 11.15, p = .001. Participants in the public feedback groups indicated that they talked more with a colleague about their conservation scores (M = 3.65, SD = 1.99) than participants in the private feedback groups (M = 2.00, SD = 1.48). There was also an interaction-effect between reward type and feedback type on social interaction about energy conservation scores, F(1,57) = 4.96, p = .030. Participants that received public non-monetary rewards talked more about their conservation scores with a colleague (M = 4.39, SD = 2.00) than participants that received public monetary rewards (M = 2.62, SD = 1.50).

[10] Because the mediator and the dependent variable were both caused by the independent variable, we cannot determine whether the mediator caused the dependent variable or whether the dependent variable caused the mediator. To check the causal relations, Kenny and Baron (1986) advise repeating the last check with the expected mediator as the dependent variable and the dependent variable as the expected mediator. This regression analysis revealed that feedback type still related to the new dependent variable (motivation to improve conservation scores), ß = .25, p = .058, after correction for the marginally significant effect of the new possible mediator energy conservation on the dependent variable, ß = .26, p = .063, while it should diminish for energy conservation to be a mediator. Therefore, we can be sure that energy conservation was *not* a mediator for the relation of feedback type on motivation to improve conservation scores, but that motivation to improve conservation scores *was* a mediator for the effect of feedback type on energy conservation.

If social interaction was a mediator for the effect of feedback type on energy conservation, the effect of feedback type on energy conservation should decline after correction for social interaction about energy conservation scores. For this check, a multiple regression analysis was carried out. Reward type, feedback type, and social interaction about energy conservation scores were the independent variables, and energy conservation was the dependent variable. This analysis showed that feedback type still related to energy conservation, although with reduced significance (ß =.22, p = .094), after correction for the non-significant relation of social interaction about energy conservation scores with energy conservation (ß = .09, p = .529). Although social interaction about energy conservation scores was influenced by feedback type, it was not a mediator for the effect of feedback type on energy conservation.

Because feedback type related to social interaction about energy conservation scores as well as to motivation to improve energy conservation scores, we checked if social interaction about energy conservation scores mediated between the effect of feedback type on motivation to improve energy conservation scores. A multiple regression analysis was carried out with feedback type, reward type and social interaction about energy conservation scores as the independent variables, and motivation to improve energy conservation scores as the dependent variable. This analysis showed no significant relation of feedback type with motivation to improve energy conservation scores (ß = .21, p = .11), after correction for the significant relation of social interaction about energy conservation scores with motivation to improve energy conservation scores (ß = .28, p = .045). A Sobel-test revealed that social interaction was a significant mediator for the relation between feedback type and motivation to improve energy conservation scores, Z = 1.77, p = .038 (one-tailed). Social interaction about energy conservation scores was a mediator for the effect of feedback type on motivation to improve energy conservation scores.

Positive emotions

We hypothesized that post-intervention positive emotions (i.e., pride and satisfaction) would mediate the effect of reward type on energy conservation, such that non-monetary (vs. monetary) rewards would lead to more positive emotions, which in turn would increase energy conservation. Therefore we carried out the second step in the mediation model of Baron and Kenny (1986): we tested the effects of our manipulations on positive emotions. As a covariate, the pre-test item

"Conserving energy makes me feel good" was inserted to control for pre-test scores on this item.

As expected, a two-way independent ANOVA revealed a significant main effect of reward type[11], $F(1,53) = 4.01$, $p = .050$. Non-monetarily rewarded conditions experienced more positive emotions after receiving the Energy Saving Reports ($M = 3.85$, $SD = 1.47$) than monetarily rewarded conditions ($M = 3.34$, $SD = 1.58$).

To check if positive emotions were a mediator for the effect of reward type on energy conservation, a multiple regression analysis was again carried out. Reward type, feedback type and positive emotions due to our manipulations were the independent variables, and energy conservation was the dependent variable. Reward type still related to energy conservation ($ß = .41$, $p = .002$) after insertion of the marginally significant relation of positive emotions with energy conservation ($ß = .22$, $p = .090$). Positive emotions did not mediate the effect of reward type on energy conservation, disconfirming hypothesis 6.

To summarize, mediation analyses confirmed one of the four predicted mediation-effects: Motivation to improve energy conservation scores partly mediated the effect of feedback type on energy conservation (hypothesis 7), meaning that public (vs. private) feedback groups were more strongly motivated to improve their energy conservation scores, which related to higher energy conservation. Hypotheses 5, 6 and 8 were rejected: Motivation to improve energy conservation was not a mediator for the effect of reward type on energy conservation (non-monetary rewards caused no higher motivation to improve energy conservation scores than monetary rewards). Also, social interaction was not a mediator for the effect of feedback type on energy conservation, although public feedback led to more social interaction than private feedback. And, positive emotions were not a mediator for the effect of reward type on energy conservation, although non-monetarily rewarded participants experienced more positive emotions than monetarily rewarded participants, and although positive emotions had a marginally significant positive relation with energy conservation.

[11] There was a significant effect of the covariate pre-test conservation positivity, $F(1,53) = 9.71$, $p = .003$. There was no effect of feedback type on positive emotions, $F(1,53) = 1.67$, $p = .202$, nor was there an interaction-effect, $F(1,53) = 0.06$, $p = .814$. Groups that received private feedback reported equal positive emotion scores, $M = 3.26$ ($SD = 1.56$) compared to groups that received public feedback, $M = 3.95$ ($SD = 1.45$).

We found one additional mediation-effect. Social interaction about energy conservation scores (talking with a colleague about scores) turned out to be a partial mediator for the effect of feedback type on motivation to improve energy conservation scores: Public (vs. private) feedback groups talked more about their scores with colleagues, which caused a higher motivation to improve energy conservation scores.

Moral reasons to conserve energy

On the post-test questionnaire, participants were asked to indicate to what extent they (in general) had moral reasons to conserve energy. A two-way independent ANOVA was carried out with our manipulations as factors and the scores on moral reasons to conserve energy as the dependent variable. The ANOVA revealed a significant main effect of reward type, F (1,57) = 4.06, p = .049. Monetarily rewarded participants reported a higher agreement with the statement that they conserved energy because of moral reasons (M = 5.83, SD = 0.89) than non-monetarily rewarded participants (M = 5.18, SD = 1.42).[12] This effect is discussed below.

Discussion

Effects of reward type and feedback type on energy conservation

The results of this study supported our main hypotheses. As predicted, non-monetary rewards had a stronger positive effect on energy conservation compared with monetary rewards, and public feedback had a stronger positive effect on energy conservation compared with private feedback. The effects of non-monetary rewards on energy conservation were strong: Eight weeks after we stopped providing feedback and rewards, participants in non-monetary reward conditions still conserved energy.

At the group level we saw that public non-monetary rewards were most effective: during all intervention and post-intervention periods, the public non-monetary condition showed the highest energy conservation of all conditions. On average, their overall energy conservation was 6.38% (SD = 6.82). The effects of private monetary rewards were also remarkable: From the first manipulation week on, private monetary rewards worked counterproductively. This condition showed

[12] No effect of feedback type on moral reasons to conserve energy was found, F(1,57) = .087, p = .770, nor was there an interaction-effect of reward type and feedback type on moral reasons to conserve energy, F(1,57) = 2.43, p = .125.

negative energy conservation during the intervention and post-intervention periods, although the difference with their baseline consumption was non-significant.

These findings are important and remarkable. People generally expect monetary rewards to have a stronger positive effect on behavior than non-monetary rewards. Policymakers often try to increase people's pro-environmental behaviors by emphasizing or creating financial incentives contingent on these pro-environmental behavior choices. The results of this study suggest that this strategy should be reconsidered, at least when energy conservation is addressed.

Our results are in accordance with the predictions of goal-framing theory (Lindenberg, 2001), which posits that strategies focusing on normative aspects of pro-social behavior are more effective in stimulating pro-social behavior than strategies that focus on material or hedonic aspects of pro-social behavior. Goal-framing theory states that in this way a normative goal frame can become dominant which may lead people to consider normative aspects of behavior choices as most important, making pro-social behavior choices likely. In line with this theory, the current study shows that the use of feedback with social recognition (normative, social interventions) for pro-environmental, normative behavior, is more effective in stimulating energy conservation than the use of feedback with a monetary compensation (a normative, social plus material intervention). Not only did more positive effects occur when the social rewards were present, they even continued for a long time after rewards were no longer provided.

Although our main hypotheses were supported by our data, the predicted interaction between reward type and feedback type was not found: Public feedback did not increase the effect of non-monetary rewards more strongly than it increased the effect of monetary rewards. In fact, during the first intervention week, the reverse seemed to be true: public feedback increased the effect of monetary rewards more strongly than it increased the effect of non-monetary rewards. Private non-monetary rewards had a relatively strong positive effect on energy conservation. The effect of private non-monetary rewards was almost as strong as the effects of public non-monetary and public monetary rewards on energy conservation. On the contrary, private monetary rewards had no effect on energy conservation. After the first intervention week, the interaction effect was no longer significant. This could be partly ascribed to a decline in conservation in the public monetary reward condition after the first intervention week. In the public monetary reward condition the mere

announcement of the rewards apparently had a more positive effect than the rewards themselves. It is possible that the public feedback aspect of the reward was more appealing than the monetary aspect of the reward. In addition, it may have been the case that the public monetary manipulation turned out to be less interesting than expected. After the first intervention week, it was basically the type of reward (monetary versus non-monetary) that caused different effects on peoples energy conservation behavior.

Recorded versus self-reported energy conservation behavior

The effects of our manipulations on energy conservation were not replicated by self-reported energy conservation. Participants in non-monetary reward and public feedback conditions reported no stronger improvements in their energy conservation behaviors than participants in monetary reward and private feedback conditions. Yet, on the post-test questionnaire, higher conservation scores were reported than on the pre-test questionnaire, suggesting that participants felt they had increased their energy conservation behaviors. This confirmed that in general, our manipulations had a positive effect on reported energy conservation behavior. The following reasons can explain why there were no main effects of our manipulations on the self-report scales: First, the self-report scales did not cover all possible conservation behaviors. The answers on the self-report scales gave us a rough idea of people's conservation behavior while the data recorded by the measurement plugs were much more precise. Second, the self-report scales had mediocre levels of internal consistency. This makes it questionable whether the self-report scales measured energy conservation behavior well. Third, the self-report scales gave us data that were much more subjective than the data recorded by the measurement plugs making them less reliable. For instance, participants had to indicate on a Likert scale how much attention they paid to their energy use at work. Answers to this item were very subjective: what one person considers as much attention may be considered as not that much attention by another person. Thus, participants who gave themselves an average score could easily have obtained different energy conservation recorded by the plugs. Therefore, we do not consider the results that we obtained from the self-report scales as a threat to our conclusions which we based on the recorded data.

Mediators

In accordance with our expectations, motivation to improve energy conservation scores was higher in public feedback conditions than in private feedback conditions. This difference explained why public feedback had a more positive effect on energy conservation than private feedback: Motivation to improve energy conservation was a mediator for the effect of feedback type on energy conservation. In the public feedback conditions people were more strongly motivated to improve their energy conservation than in private feedback conditions, which led to a stronger increase in energy conservation in public feedback conditions.

Furthermore, social interaction was higher in public feedback conditions than in private feedback conditions, especially in the public non-monetary condition. However, contrary to what we predicted, this did not explain the effect of feedback type on energy conservation. Rather, social interaction turned out to be a mediator for the effect of feedback type on motivation to increase energy conservation scores. Participants who were publicly rewarded talked more about their scores with colleagues than participants who were privately rewarded, which led to a higher motivation to improve conservation scores among those who were publicly rewarded than among those who were privately rewarded. Based on these findings we can conclude that the relation between public feedback, social interaction (talking about energy conservation scores) and motivation to improve energy conservation is highly relevant to energy conservation behavior among employees.

Contrary to our predictions, we did not find support for the mediation effects for the effects of reward type on energy conservation. Participants in monetary reward conditions had no higher scores on motivated to increase energy conservation scores than participants in monetary reward conditions: Motivation to increase energy conservation scores was not a mediator for the effect of reward type on energy conservation. Also, there was no mediation by positive emotions for the effect of reward type on energy conservation, although non-monetarily rewarded participants indicated that they were more frequently proud and satisfied after reading their Energy Saving Reports than monetarily rewarded participants. That non-monetary rewards were better in generating positive emotions about one's own conservation scores compared with monetary rewards may be related to the fact that non-monetary rewards are less tangible than monetary rewards. Tangible rewards undermine self-regulation (Deci, Koestner & Ryan, 1999). This can decrease a feeling of being self-

determined and competent, in contrast with less tangible non-monetary rewards. Non-monetary rewards can affirm a feeling of being competent, and leave people relatively more self-determined in their decision, whether they want to improve their behavior or not. We expect that a feeling of being self-determined and competent positively correlates with positive emotions. This expectation is supported by Fehr and Falk (2002) who state that social approval makes people feel proud and happy.

We found one other effect of reward type: Monetarily rewarded participants reported a stronger positive agreement than non-monetarily rewarded participants on the item: "Conserving energy is something that I do for moral reasons" posted on the post-test questionnaire. It is likely that participants who received a monetary reward for their conservation change felt a stronger urge to reflect their moral reasons to conserve than participants who received a non-monetary reward. This may be because monetarily rewarded participants were not able to communicate their moral intentions in their conservation behavior because they were monetarily stimulated to conserve. In other words, because they received a monetary reward, they risked that their energy conservation would be interpreted as extrinsically motivated. By their high score on this item they might have want to let us know their true intentions (that they were more likely to conserve energy for moral reasons than for money). Interestingly, if we consider our four experimental conditions, participants in the private monetary reward condition were the only ones that had no possibility to communicate that they were non-monetarily, morally or ethically motivated: people in the two public conditions could tell their colleagues they were not in it for the money, and people in the private non-monetary condition could show their motivation by conserving energy for nothing more than a pat on the back. It may well be that the effects of reward type on energy conservation that we found in this study were partially caused by the opportunity people had to show their true intentions: if people were able to show that they were morally/ethically motivated to conserve energy, they conserved energy, if it was impossible to show this intrinsic motivation, they did not. This is an interesting explanation to address in future research.

Limitations

A limitation of these results is that the effects of rewards and feedback were combined in one intervention. We tried to make our manipulations as strong as possible, and in doing so, we introduced minor confounds. In all experimental

conditions, participants received feedback *and* a reward to stimulate energy conservation. Therefore, we can not be sure which aspect of our manipulations caused our results: the private feedback, the comparison information, the type of reward, the fact that participants in public conditions were less anonymous, or a combination.

Another limitation of this study is the quasi-experimental set-up that we used. We could not randomly assign participants to conditions because it was of importance that participants did not know manipulation differences. This was a potential threat to internal validity. However, we randomly assigned groups to conditions and used a pre-test questionnaire to control for possible differences between participants. Therefore, we ruled out as much of this possible threat as possible.

Strengths

Quasi-experimental field studies also have an important advantage: the results can be more easily translated into a useful policy. We showed in a 'real life' situation that stimulating employees to conserve energy at work can be effective when non-monetary rewards and public feedback are used. Although it may take some time and effort for managers to organize these incentives, we showed that it is a very effective and cheap strategy. Providing non-monetary rewards for employees' energy conservation does not cost any money, and because employees will likely conserve energy, the provision of public and non-monetary rewards reduces costs on a company's energy consumption bill. This is a much more cost-effective strategy than the use of monetary rewards. Monetary rewards are more expensive: the reward itself is more costly and their use is also inefficient because, as we have shown, it is likely that these rewards will not result in an improvement in energy conservation.

Other strengths of this experiment are related to the innovative measurement method that we used. The measurement devices that we used gave us the possibility to unobtrusively collect extremely detailed information about peoples' energy consumption. In contrast with most other energy conservation studies (see Abrahamse et al., 2005), this method enabled us to precisely record real energy conservation behavior. Moreover, participants indicated that they believed the feedback that we sent them was reliable and accurate, which indicates that people trusted this new measurement system.

Due to this measurement system it was also easier to measure longer-term effects of our manipulations. We recorded consumptions for thirteen weeks in total.

Frequently, studies repor short-term effects only (Lehman & Geller, 2004; Abrahamse et al., 2005). With this new measurement system we were able to add knowledge about how effects of feedback and rewards play out over longer periods of time.

It is also important to remember that the percentage energy conservation that we used in our analyses were very conservative. We did not include hours in our analyses during which people could have been engaged elsewhere. Therefore we included a maximum of two consecutive low-level consumption hours in our analyses even when more of these low-level consumption hours were recorded. Thus, in fact, true energy conservation was somewhat higher than reported.

Generalizability and implications of this research

The success of an incentive program also depends on the socio-psychological make-up of the population (Samuelson, 1990). The people who participated in this study worked for a company that designed products and processes for a sustainable energy supply. It is likely that they had a relatively positive attitude towards energy conservation compared with employees in other companies This has implications for the generalizability of the results. The effects of rewards and feedback might have been weaker if employees with a less positive attitude towards energy conservation had participated. One might think that the counterintuitive effect of a monetary reward is mainly present in such a group of participants, and that in other groups monetary incentives are more relevant. An example of a study that showed positive effects of monetary incentives in certain groups comes from Bashir, Sarkissian, Lockwood and Dolderman (2010). They compared immigrants that likely had a rather material goal frame with non-immigrants who had a relatively less material goal frame about their intentions to engage in pro-environmental behaviors. Participants first read a message about either financial or non-financial benefits of pro-environmental behavior. For non-immigrants, no effects were found while higher pro-environmental behavior intentions were found for immigrants who read the message about financial benefits of that behavior.

Although this is an example of restricted generalizability of our results, we also have reasons to assume that our results can be generalized to other groups of employees. First, our results are in accordance with conclusions derived from the extensive meta-analysis of Deci, Koestner and Ryan (1999) who concluded that tangible rewards crowd out intrinsic motivation for interesting tasks while verbal

rewards can crowd in intrinsic motivation. Deci et al. argue that tangible rewards undermine self-regulation which decreases people's feelings of being responsible for motivating themselves. Because a meta-analysis is based on a broad variety of studies with a broad variety of participants, and because our results are in accordance with the conclusions derived from this meta-analysis, it gives us reason to think that our results are not completely dependent on the socio-psychological make-up of our participants.

Second, conserving energy is becoming a widely established social norm. Therefore, it is reasonable to think that people with an 'average' pre-intervention attitude towards pro-environmental behavior would also be spurred into action when feedback and social recognition about their behavior is given in relation to this norm. This makes it likely that our results can be generalized to employees' energy conservation behavior at the workplace in general. Additionally, we think that our results can be generalized towards environmental domains such as water-usage, recycling, and purchasing pro-environmental products. Just like energy conservation, these are all examples of pro-environmental behaviors that are relatively less costly in terms of money, time or social approval. In decisions involving these low-cost environmental behaviors, normative goals already play a relatively important role (Lindenberg & Steg, 2007) and therefore can become dominant relatively easy. In high-cost pro-environmental behavior situations, such as the decision to travel with public transport instead of using a car, or the purchase of a hybrid car, material or hedonic goal frames may be more difficult to overcome. In these situations, it is more questionable if social rewards would have sufficiently strong effects.

Future research questions

In follow-up studies, it will be interesting to include two additional experimental conditions in which participants receive private or public feedback only (without an accompanying reward). This makes it possible to compare the effects that we found with the sole impact of private versus public feedback. There are also relevant questions related to the mediation-effects that we found for the effect of feedback type on energy conservation. Public feedback led to an increased motivation to conserve energy, which led to an increase in energy conservation, and public feedback led to an increase in social interaction, which led to an increase in motivation. Although this is valuable information, we do not know the content of the social interaction (i.e., what participants in public feedback conditions talked about

with their colleagues) that increased their motivated. Did they talk about ways to improve their energy conservation scores? Were they motivated to obtain or keep a pro-social reputation? Or were they just more competitive? These questions are highly relevant to understanding how to improve energy conservation behavior more effectively.

With regard to the effects of monetary versus non-monetary rewards on energy conservation, further exploration of the finding that non-monetarily (vs. monetarily) rewarded participants were more frequently proud and satisfied is warranted. The effects of non-monetary rewards on conservation behavior were strong, consistent and long-lasting, so it seems relevant to further explore motivation-relevant variables that can explain this effect. This may be related to the idea that an increase in energy conservation behavior is partly produced by the degree to which people can display their moral/ethical behavior. We found that monetarily rewarded participants reported higher scores on moral reasons to conserve energy compared to non-monetarily rewarded participants. Monetarily rewarded participants had fewer/no possibilities to show their moral intentions. This might have been one of the reasons for the less positive effect of monetary rewards on energy conservation. Future research should address this possible explanation.

The study by Bashir and colleagues (2010) showed positive effects of financial incentives for pro-environmental behavior on intentions to act pro-environmentally among people with material goal-frames that are rather material. This suggests that it would be interesting to shed more light on the moderating effect of pre-intervention goal frames on the effects of feedback and incentives on pro-environmental behavior. It seems likely that the effects of monetary rewards on pro-environmental behavior, for example, would be stronger for participants with a material goal frame than for participants with a different a goal frame. A better understanding of these processes would lead to knowledge that is highly relevant for policy makers serving different populations.

Conclusions

In this field study, we showed that non-monetary rewards can have a strong positive effect on energy conservation while monetary rewards do not work as well. Although not all of our mediation predictions were confirmed, we showed that non-monetary rewards were associated with stronger positive emotions than monetary

rewards. Furthermore, public feedback had a stronger positive effect on energy conservation compared with private feedback. This effect was mediated by a higher motivation to improve energy conservation scores. In addition, social interaction turned out to be the reason why public feedback experienced a higher motivation to conserve.

These conclusions add to the literature about the effects of reward and feedback on pro-environmental behavior and are especially informative for creating effective policies in organizations. We advise policy-makers to use social rewards, such as feedback and public praise, to strengthen peoples' normative goals to be pro-social and moral. This study shows it is likely that this will be a more (cost) effective strategy than appealing to peoples' self-interest by accentuating or creating monetary incentives.

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Appendices

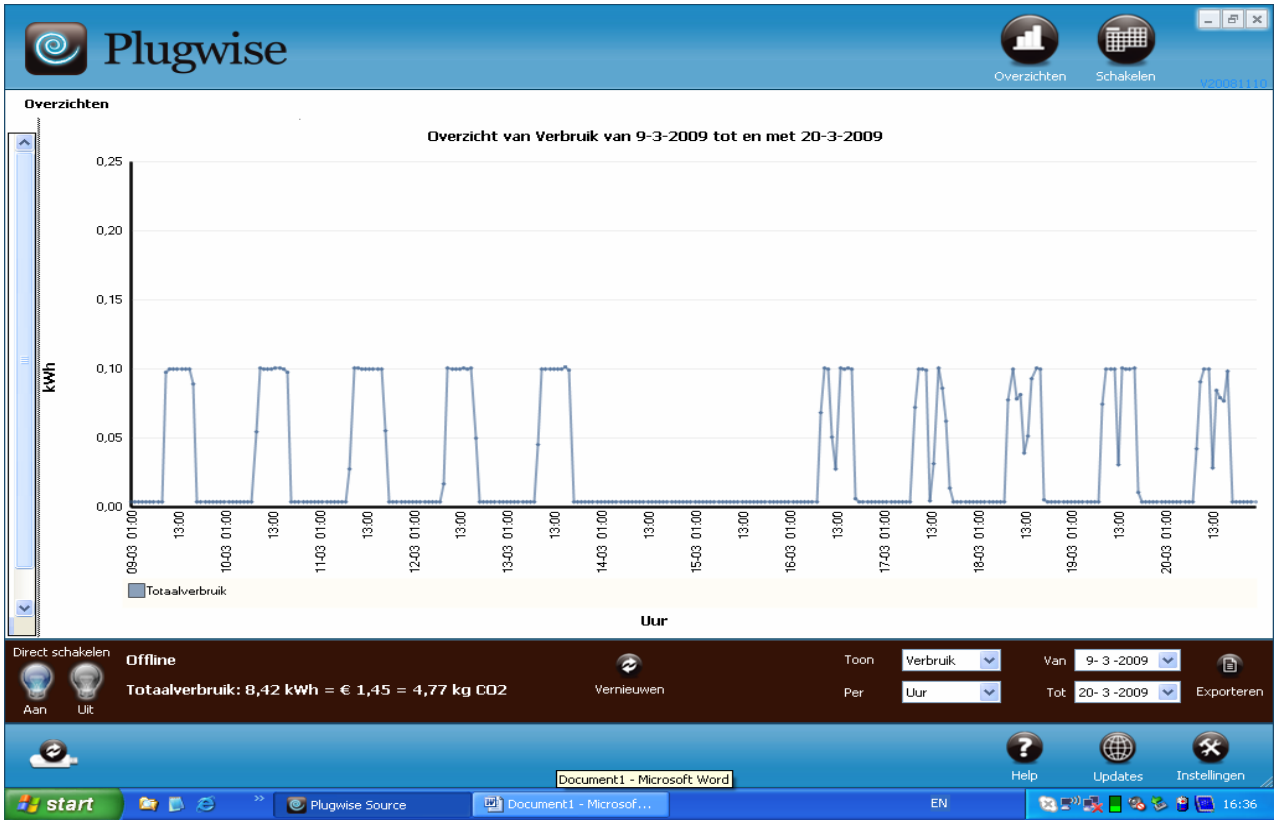
Appendix 1: Classification of hours as working versus non-working hours.

Hours were counted as working hours as soon as the average energy consumption level exceeded 10Wh per hour (the threshold for the night) after 6:00 am. The first and last hour above this level were excluded, because the algorithm could not detect when exactly people had started or ended working during these hours. Furthermore, a maximum of two consecutive hours below 10 Wh per hour, in between two working-hour(s), was included in analyses. We did not ascribe more than two consecutive low-level consumption hours to intentional energy conservation behavior, because during these hours participants were probably engaged elsewhere.

Non-working-hours were the hours from 12:00 pm until 6.00 am, plus the hours from 6.00 am until one hour before the first working-hour, plus the second hour after the last identified working-hour until 12:00 pm that day. The algorithm started counting at 12.00 pm to detect non-working consumption levels above 10 Wh per hour made by computers which were (un)intentionally kept on during the night. This behavior would otherwise have been neglected.

Appendix 2: Example of how the measurement system displays energy consumption recorded by a plug.

The graphic below is an example overview that shows recordings made by one measurement plug. The horizontal axis represents the timeline (in hours) and the vertical axis represents the energy consumption level of the device that was connected to this plug (in Kilowatt-Hours). This overview consists of 10 working days. During the second week depicted (the week that we started the intervention), this participant probably started using the stand-by function of his/her computer: During lunchtime a strong decline in Watt-hours occurred.



Appendix 3: Ratio used to convert conservation percentages into rewards.

A ratio of 4:1 was used to convert the energy conservation percentages made during working versus non-working hours into one conservation score. This score directly related to the amount of money or the grade that one received. The 4:1 ratio allowed us to control for the additional effort that was needed to conserve energy during working versus non-working hours.

Appendix 4: Example of an Energy Saving Report.

This is an example of an Energy Saving Report in the monetary reward conditions. A similar report with a grade instead of a certain amount of Euros in the colored field- was sent to participants in the non-monetary reward conditions.

Energy Saving Report

Name	**Name**	
Measurement dates	Norm until:26-2-2009 Measurement from: 10-3-2009 until 13-3-2009	
Day part*[1]	**Day**	**Night**
Norm consumption (average Wh per hour)	92,4	9,2
Actual consumption (average Wh per hour)	85,0	3,0
Realized energy saving percentage	**8,0**	**67,8**
Score definition ratio*[2]	80%	20%
Day part score value	2,13	1,36
Money earned with score (0-5 Euro)	**€ 1,7**	
Reference days in score	*3*	*4*
Reference hours in score	*22*	*70*

*[1] The total amount of measures hours are divided in *day* and *night* hours. A day hour is an hour in which your average power consumption rises above 10W per hour. The first and last hours that you consumed more than an average of 10W are excluded, because the algorithm can not detect whether you are present during the entire hour. During the day you might turn your computer to standby/off when you go out for lunch or a meeting and therefore you could have reached a lower level of consumption than 10W. If so, a maximum of two hours at this level are included in your Day score. When a power level of < 10W is reached for more than two hours, these hours are excluded from your Day score. Your Night score is based on your average power consumption from 0:00 until your first working hour plus the hour after your last working hour until 23:59 that day. The average of all relevant day and night hours in a week will be calculated, your amount of reference hours is displayed in the bottom of the table.
*[2]The Score definition ratio is based on the effort that belongs to your conservation at that Day part. It can be assumed that it takes more effort to conserve percentages of energy during the day than during the night.

Appendix 5: Manipulation of public feedback.

This is an example of how we manipulated public feedback in the public monetary condition. A similar table was sent to participants in the public non-monetary condition, although we displayed grades with accompanying short comments, as described in the Method section, instead of Euros.

Total amount of money earned with conservation

WEEK 11

	€ 0	€ 0-1	€ 1-2	€ 2-3	€ 3-4	€ 4-5	No Score	€ (Total)
Name 1						4.3		4.3
Name 2			**1.7**					1.7
Name 3			1.6					1.6
Name 4		0.8						0.8
Name 5		0.8						0.8
Name 6		0.5						0.5
Name 7		0.3						0.3
…		0.2						0.2
…		0.2						0.2
…		0.2						0.2
…		0.2						0.2
…		0.1						0.1
…	0							0
…	0							0
…	0							0
…							x	

The total amount of money (max. €15) that you have earned with your conservation, will be handed to you by the University of Amsterdam in a closed envelope as soon as this research has been finished.

-YOUR PERSONAL ENERGY SAVING REPORT AT NEXT PAGE-

Appendix 6: Tables

Table 1

Overall energy conservation (in percentages) per group.

Group	*M*	*SD*	*n*
public non-monetary	6.38	6.82	18
private non-monetary	4.79	6.02	16
public monetary	1.91	5.42	16
Control	0.47	3.99	16
private monetary	-2.40	9.42	17

Table 2

Conservation (in percentages) per group for the weeks of the intervention.

	Week 1			Week 2			Week 3		
Group	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*
Public Non-Monetary	3.12	9.21	18	6.16	8.80	18	9.81	9.37	18
Private Non-Monetary	2.15	7.26	16	4.71	6.20	16	5.95	7.17	16
Public Monetary	4.50	7.54	16	3.78	11.20	16	1.01	9.33	16
Control	-0.69	3.34	16	0.55	3.73	16	0.93	4.56	16
Private Monetary	-3.76	8.67	17	-3.46	10.26	17	-0.85	11.95	17

Table 3

Effects of reward type (monetary vs. non-monetary) and feedback type (private vs. public) on the change from pre-test (Q1) to post-test (Q2) self-reported energy conservation.

	Q1		Q2		Q2-Q1	*n*
	M	*SD*	*M*	*SD*		
Monetary reward	4.32	1.34	4.65	1.11	0.33	28
Non-Monetary reward	4.60	0.83	4.92	0.96	0.32	31
Public feedback	4.55	1.06	4.98	0.96	0.43	30
Private feedback	4.39	1.16	4.60	1.10	0.22	29