MOTIVATING PRO-ENVIRONMENTAL BEHAVIOR: THE USE OF FEEDBACK AND PEER EDUCATION TO PROMOTE ENERGY CONSERVATION IN AN ORGANIZATIONAL SETTING

By

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Dissertation

Submitted to the Faculty of the

Graduate School of Vanderbilt University

in partial fulfillment of the requirements

for the degree of

DOCTOR OF PHILOSOPHY

in

Psychology

August, 2009

Nashville, Tennessee

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To my parents

ACKNOWLEDGMENTS

I am fortunate to have a number of people to thank, both personally and professionally. First and foremost, I would like to thank my advisor Bill Smith for his mentorship and for allowing me the room to pursue multiple interests throughout my graduate school career. I have enjoyed our collaboration immensely. Thanks to the members of my dissertation committee for their helpful comments and for their willingness to provide mentorship in all areas of my scholarly development. I am particularly grateful to Bruce Barry, who has been a valued colleague and advisor throughout my time here, to Ken Wallston for his thoughtful advice regarding the methods and analyses in this dissertation, as well as to Michael Vandenbergh for helping to shape my thinking of this research and challenging me to consider its contributions from multiple perspectives.

This research would not have been possible without the funding and assistance provided by Vanderbilt's Sustainability and Environmental Management Office. A special thank you to Andrea George for working diligently to secure the financial and institutional support to move this project along. Kendra Abkowitz, Jessica Ji, and Steve Gild devoted long hours to the project's preparation as well as to data collection. Mark Petty and members of Plant Operations provided access to the kilowatt hours data, which made this project possible. I would also like to thank my friend and colleague Dr. Manuel Riemer. Manuel was closely involved in the design and development of this project and provided invaluable support at multiple stages of the development of this dissertation.

Finally, I would like to thank my friends and family for providing humor and perspective these past few years. I would especially like to thank Neil for his incredible love and support, particularly in recent months. Thanks to good friends, you know who you are, and to my very large and gregarious family. And thank you to my mother and father who have made countless sacrifices, without hesitation or expectation, to provide me with the opportunities I have had. There are no words to express the depth of my gratitude.

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CHAPTER I

INTRODUCTION

There is a growing consensus among scientists and policy-makers that current trends in the production and consumption of energy in the United States are unsustainable. These concerns are largely due to the emission of greenhouse gases, which are the primary agents responsible for global climate change (IPCC, 2007). In their recent report, the Intergovernmental Panel on Climate Change (IPCC) concluded that there is “unequivocal” evidence that the global climate is warming and, if not abated, rising temperature could have calamitous effects on human health, ecosystems, infrastructure, coastal systems, food supplies, etc. (IPCC, 2007). Additional concerns are borne in the economic and social costs of energy production, such as international conflict, air pollution, cost inflation, and resource shortages.

Recent debates over how to reduce the negative impact of energy use have focused primarily on supply-side measures, such as the implementation of low-emission technology and the economic regulation of industry. While these efforts are critical to developing a more sustainable economy, there is a growing realization that the current problem is as much psychological as it is technical. At a basic level, the public’s concern over this issue is critical to the success of policies and interventions. Likewise, for technological advances to be effective, they must be adopted by a critical number of consumers who, historically, have been reluctant to invest in low-emission technology over less expensive and more established products (for review, see Brown, 2001). Furthermore, reductions in emissions that have been achieved through advances in technology have been largely offset by consumers who are acquiring more commodities and using them more frequently. For example, the reduction in fuel use associated with the development of more fuel-efficient vehicles has been almost fully compensated by increases in the number of vehicles on the road and total vehicle miles traveled (US Environmental Protection Agency, 2000). A similar story applies to the integration of more efficient refrigerators into the marketplace, where a large proportion of households have purchased newer more efficient models, but retained their old one for extra storage (Young, 2008).

With these issues in mind, there is a need for policies and interventions that will address this problem on multiple levels, including the production of energy, the development of commodities that use energy, as well as consumer demand for energy. The research discussed here addresses the latter of the three by examining the effectiveness of two interventions, behavioral feedback and peer education, in reducing consumer demand for electricity in an organizational setting. These two approaches were selected based on their strong theoretical and empirical support as behavior change strategies, as well as the feasibility of their being implemented in a work-place setting. After reviewing the relevant research on situational and psychological factors associated with energy use, these interventions will be discussed in more detail, including a review of previous efforts to evaluate their effectiveness. Chapter II will describe the present study, which involved a randomized and controlled field experiment in which each intervention was evaluated relative to a comparison group that received only basic information about energy use. Analyses and results of these interventions will be described in Chapter III, including an examination of their overall effect on energy use, as well as the psychological processes associated with these effects. Finally, Chapter IV will discuss the conclusions that can be drawn from these results, as well as the implications of these findings in light of current efforts to promote voluntary behavior change.

A Psychological Analysis of Electricity Use

Like all environmentally significant behaviors, the decision to use electricity not only affects the well-being of the person who uses it, but also others who draw from the same energy supply, breath the same air and share the same climate. Electricity consumption can be classified as a social dilemma, or a situation in which the immediate interests of the individual are in conflict with the long-term interests of the group to which the individual belongs (Samuelson, 1990; Stern & Gardner, 1981). Social dilemmas are characterized by at least two properties (Dawes, 1980): (1) each person receives a higher immediate payoff for a non-cooperative decision, and (2) the collective is better off when individuals choose to cooperate rather than to act according to their own self-interests. As such, each person involved must make a choice between what is personally most rewarding in the short-term, and what will be better for the group in the long-term. The rational option for each individual in the short-term is to maximize immediate personal gains; however, if this option is chosen by enough members of the group, then everyone involved will suffer worse outcomes in the long-term than if fewer or none had chosen this option.

Electricity use fits the definition of a social dilemma on multiple levels. In one sense, this issue can be thought of as a resource dilemma given that it involves multiple parties drawing from a common source of fuel for electricity. Resource dilemmas emerge over shared resources because all individuals desire to use as much of the resource as they want or need; yet, if all consume without restraint, the resource will be depleted and everyone involved will suffer. Hardin's (1968) classic analogy "the tragedy of the commons" is an example of a resource dilemma, as are currents trends in the consumption of other natural resources such as fish, timber and water. In the case of electricity production, unrestrained consumption will, theoretically, lead to the eventual exhaustion of energy supplies in the long-term. However, of more immediate concern is the effect that rising demand has on the cost of energy in the short-term, as well as the ability of utility companies to meet peak-load requirements for electricity. In all cases, the collective interest of the group is for individuals to moderate consumption to avoid or lessen undesirable outcomes.

On a second level, electricity use can be characterized as a public goods dilemma, in which the conservation of energy is necessary for the provision of public goods such as clean air or a stable climate. By definition, a public good is a publicly available commodity that is provided only if a certain level of a resource is contributed to maintain it. Common examples include public radio, labor unions, and cultural events such as the local orchestra or ballet. In the case of energy use, the "resource" that is contributed to maintain a public good is the money or effort required to reduce consumption. For example, an individual who invests in better home insulation or an energy efficient appliance may incur a personal cost for doing so; however, this cost also equals a contribution towards the provision of cleaner air or the reduction of climate change. The dilemma exists because public goods are non-exclusionary and are, therefore, available for everyone to use whether an individual contributed to its provision or not. As a result, there is a temptation to "free ride", or to enjoy the benefits of a public good without making sacrifices for its provision.

To some extent these dilemmas are mitigated by the fact that many consumers pay per unit of electricity used and, as a result, there exists a built-in payoff structure to promote prosocial behavior. However, it is commonly held that the cost per unit of electricity in the United States is too low to fully account for the range of externalities that result from its consumption, particularly within the context of climate change and resource extraction (e.g., Carlson, 2002; Owen, 2006). Furthermore, there are many situations in which individual consumers of electricity do not pay for their usage. This is often the case in rented apartments where utilities are provided, or in organizational settings where energy use is determined by the behaviors of individual employees but is paid for centrally by the organization.

Based on traditional notions of rational behavior (e.g. Von Neumann & Morgenstern, 1944), the most beneficial decision for any individual involved in a social dilemma is to choose the course of action that will, first and foremost, minimize potential harm and, second, maximize potential gains. The "harm" that is to be minimized in this context is the reduced access to energy that may result from the decision to conserve energy, or the loss of the energy-providing resource altogether. On the other hand, the most personally beneficial decision for the individual is unrestrained energy use, or consumption that is based on self-serving motivations such as the desire to maintain levels of comfort and convenience, or due to habit. Examples might include turning the thermostat up to the highest setting during the winter, leaving lights on in unoccupied rooms for decoration or convenience, or acquiring new appliances without regard to their energy-intensity. Both the “least risky” and potentially most beneficial option for the individual is unrestrained energy use; however, if this logic is followed by enough individuals within the group, problems associated with over-consumption cannot be solved. It is for this reason that many scholars have argued that social dilemmas are unsolvable, particularly in the absence of a governing party to regulate behavior (e.g. Buchanon & Tullock, 1962; Hardin, 1968).

Psychologists have offered a slightly different interpretation of this issue. Although most would not disagree that individuals tend to behave in “self-interested” ways, their definition of self-interest generally incorporates a much broader spectrum of motives than the primarily economic definition that has traditionally been employed by economists (Smith, 1991; Smithson & Foddy, 1999). An individual’s *subjective utility* of an outcome is believed to be determined by a number of factors beyond its net economic value, such as the extent to which an outcome is consistent with an individual’s values, self-concept, or ideological world-view. This model is better able to account for the substantial number of individuals who do choose to cooperate in social dilemmas (e.g., Bicchieri, 2001). Likewise, it better explains why human decision-making so often departs from is expected based on the rational-actor models, such as why individuals tend to overlook factors such as product efficiency and operating costs when making purchasing decisions (e.g., Brown, 2001; Turrentine & Kurani, 2007). Using this perspective, the question shifts from one of how to arrange the economic payoffs in such a way as to encourage cooperation to that of targeting the social and situational factors that make it in the individual's subjective self-interest to cooperate rather than to defect. A number of variables have been identified by both social dilemma theorists and environmental psychologists. A review of some of the key findings in this literature is offered below.

Predicting Pro-Environmental Behavior

Psychologists attempting to understand pro-environmental behavior have most often looked to an individual's attitudes towards the environment as the motivating factor. In fact, nearly two-thirds of all environmental psychology publications have included this construct in some capacity (Kaiser, Wölfing, & Fuhrer, 1999). The majority of this work has measured attitudes at a general level, with questions inquiring about a person's general concern for the environment or feelings about the goal of environmental protection (e.g. Bamberg, 2003; Fransson & Gärling, 1999; Vining & Ebreo, 1992). Despite the frequency with which this construct has been studied, the relation between general environmental concern and actual ecological behavior is weak at best (e.g. Hines, Hungerford & Tomera, 1986/87; Kurz, Linden, & Sheehy, 2007). This finding extends to the realm of electricity consumption, where it has been found that those who report high concern for the environment are no more likely to engage in energy conservation practices than those who express little or no concern (e.g. Fujii, 2006; Poortinga, Steg, & Vlek, 2004; Van der Pligt, 1985).

General environmental concern is an important factor to the extent to which it leads to the development of positive attitudes towards specific behaviors, such as recycling, energy conservation, or the use of mass transit. Stern and colleagues (1995) have argued that general attitudes and values operate as a sort of filter through which congruent behavioral-specific attitudes and beliefs will emerge (Stern, Dietz, Kalof, & Guagnano, 1995). These specific attitudes, in turn, tend to be more powerful predictors of actual ecological behavior. For example, when attempting to predict recycling, studies that have measured specific attitudes, such as the feeling that recycling is a nuisance or messy, have generally had more success than those predicting recycling on the basis of general attitudes, such as overall concern for the environment (for review, see Schultz, Oskamp, & Mainieri, 1995). These findings are consistent with Ajzen and Fishbein's work (Ajzen & Fishbein, 1977; Ajzen, 1991), which suggests that the attitude-behavior relation can be severely attenuated when the two are measured at different levels of specificity. However, it is important to point out that even when this factor is taken into account, the attitude-behavior relation remains modest, generally accounting for only a small proportion of variance in behavior (e.g., Becker, Seligman, Fazio, & McConnon, 1981; Schultz, et al. 1995; Vining & Ebreo, 1992).

The role of attitudes in this context may be best understood using expectancy-value theories of behavior. This framework was originally attributed to Atkinson (1964), although today a number of theorists have modified or included this logic in their own models (for review, see Eccles & Wigfield, 2002). Expectancy-value theory and its variants argue that the tendency to behave a certain way is predicted by the expectation that an act will be followed by a given consequence, as well as the value that the individual assigns to that consequence. In other words, that an individual values a clean environment or endorses a goal to reduce his or her impact on the environment (the attitude, in this case) is a necessary, but not sufficient, condition for one to adopt an ecologically-friendly behavior. He or she must also believe that the behavior in question will lead to the attainment of this goal (i.e. a cleaner environment). This issue is critical to the prediction of environmentally-significant behaviors where the relation between an action and its impact on the environment tends to be small and difficult to observe. This is because outcomes in this context, as in all social dilemmas, are determined by the aggregate of the group rather than any one person. Furthermore, as the number of people involved increases, the impact of any one individual becomes increasingly smaller until that impact is essentially negligible. As a result, many who hold positive attitudes towards the environment, or towards specific pro-environmental behaviors, fail to act consistently with these attitudes because their actions are believed to be ineffective in achieving the desired goal.

This theory is evidenced by work that has demonstrated the relation between outcome expectancy, or the belief that a behavior will lead to a certain outcome (see

Bandura, 1977), and actual behavior. For example, in a simulated social dilemma run in a laboratory setting, Kerr (1992) presented participants with equal endowments from which they could choose to donate to a public good, or keep the money for themselves. After varying the value of their contributions, Kerr showed that those who believed their contribution to be critical to providing a public good donated their money nearly three times as often (90%) as those who believed their contribution to be insignificant (32%). Kaiser and Shimoda (1999) examined this question using a survey of over 400 Swiss participants and found that a single measure of outcome expectancy (labeled in this study as responsibility judgement) accounted for 28% of the variance in a general measure of ecological behavior. In yet another study, Steg, Dreijerink and Abrahamse (2005) measured support for an energy policy that involved a tax on electricity. Their results showed that personal values, as well as concern about energy use, were fully mediated by outcome expectancy which, in turn, led to a perceived moral obligation to take actions to reduce energy use. Unfortunately, no measure of actual behavior was included in this study.

This work suggests that, although targeting attitudes may be a necessary component to a successful intervention, by itself it is unlikely to lead to substantive behavior change. This is reflected in the numerous studies that have reported a limited effect of public information campaigns on pro-environmental behavior (e.g. Abrahamse, Steg, Vlek, & Rothengatter, 2005; Costanzo, Archer, Aronson, & Pettigrew, 1986; Henry & Gordon, 2003; Tertoolen, van Kreveld, & Verstraten, 1998). A critical component to the success of interventions that appeal to an individual's desire to protect the environment is to empower that person by promoting the belief that his or her behaviors will be instrumental in bringing about the desired outcomes. Given the scale of many environmental problems, this poses a formidable challenge for those working in this field. One promising approach that will be explored in the present study is the use of behavioral feedback to make salient to the individual the impact of his or her behavior relative to some goal. This approach will be covered in more detail in the discussion of the interventions.

The above discussion has focused on factors that motivate individuals to take steps to intentionally protect the environment based on the endorsement of a goal for environmental protection and the belief that one's actions will be instrumental in achieving that goal. However, there are number of conditions under which individuals will behave pro-environmentally for reasons beyond the desire to see direct outcomes of their behavior. Within the collective action literature, Simon and colleagues have argued for a dual-pathway model for participation in collective action movements, which also constitute social dilemmas (Simon et al., 1998; Simon & Klandermans, 2001; Stürmer, Simon, Loewy, & Jörger, 2003). The first pathway involves the calculation of costs and benefits related to the decision to participate in a movement. This model is based on the expectancy-value hypothesis reviewed above, and argues that individuals will be motivated to participate in collective action when they are committed to the goals of the movement, and when it is believed that one's personal contributions will be instrumental in achieving that goal. The second pathway involves the motivation to participate in movement activities based on the need for affiliation and social approval from a meaningful social group. In other words, individuals will participate not because of the tangible rewards that are expected, but due to its social significance or because it is customary within a group to do so.

Social psychological research on normative influence and social identity support the assertion that the need for affiliation and social approval are powerful motivators of behavior. Some of the earliest work illustrating this point is Solomon Asch's (1951) well-known study in which he showed that when a group of confederates gave the wrong answer on a simple line-judgment task, roughly 30% of naive participants volunteered the same obviously incorrect response. Further investigations into this effect suggest that participants were motivated to conform to the group out of a desire to fit in with the group's standards, or to avoid conflict, not because individuals were actually persuaded that the answer was correct (e.g. Asch, 1951; Bond & Smith, 1996). In other words, the group of confederates were indirectly communicating to the naive participants that a different norm was operating within that social setting, and those who volunteered the incorrect answer were conforming to this norm.

By definition, social norms are a mutually endorsed set of rules (both formal and informal) that guide attitudes and behavior within a group (Miller & Prentice, 1996). Norms can be both descriptive, conveying how people actually behave in a given situation, as well prescriptive (termed *injunctive norm*), which conveys what is approved or disapproved of in a situation (Cialdini, Kallgren, and Reno, 1991). While the Asch paradigm involved a relatively artificial setting, the effects of both descriptive and injunctive norms have been observed in a number of natural settings as well. Multiple studies have reported correlations between an individual's behavior and what is perceived to be typical or desirable among his or her peers. For example, perceived social norms are predictive of drinking (e.g. Borsari & Carey, 2003; Larimer, Irvine, Kilmer, & Marlatt, 1997), contraception use (Fedaku & Kraft, 2002), substance abuse (Elek, Miller-Day, & Hecht, 2006), smoking (van den Putte, Yzer, & Brunsting, 2005) and intentions to exercise (Rhodes & Courneya, 2003). While these findings could represent individuals who are self-selecting into social groups that exhibit behaviors similar to their own, additional work has found that efforts to alter social norms also result in significant behavior change (e.g. Mutterperl & Sanderson, 2002).

In perhaps the most well-known work in this area, Cialdini and colleagues (Cialdini et al., 1991; Cialdini, Reno, & Kallgren, 1990) conducted a series of field experiments in which they manipulated both descriptive and injunctive norms regarding littering. These studies took place in public parking lots in which unknowing participants were given a handbill on their way to their cars. The dependent variable was whether or not the individual threw the handbill on the ground. To manipulate a descriptive norm, the researchers arranged for the parking lot to be free of litter (descriptive norm against littering) or litter was scattered around the parking lot (descriptive norm for littering). In the injunctive norm condition, a confederate walked in front of the participant and either picked up a bag of trash that was lying on the ground (injunctive norm against littering) or walked by and did nothing (no injunctive norm). Cialdini et al. found that both descriptive and injunctive norms were related to a reduction in littering ranging from 30 to 50%. These effects have been replicated in multiple other contexts (e.g., Cialdini, 2003; Schultz, 1998).

A critical factor to the discussion of normative and social influence is the the extent to which an individual identifies with the social group that is referenced by these norms. Social identity refers to the part of person's self-concept that is based on a membership to a group or category of people (Tajfel & Turner, 1979; Turner, Hogg, Oakes, Reicher & Wetherell, 1987). According to self-categorization theory, a variant of social identity theory (Turner, et al., 1987), those who are identified with a group desire to positively distinguish themselves from significant out-groups (termed, *optimal distinctiveness*). This results both in the motivation to conform to in-group standards, via the adoption of typical attitudes, behaviors and beliefs, as well as the rejection of standards that are representative of the out-group (e.g. Stürmer et al., 2003). While norms appear to influence behavior even in situations where no identity group is made salient (Cialdini et al., 1991; 1990), a salient social identity can both bring attention to the presence of norms and amplify the desire to conform to that group (Schofield, Pattison, Hill, & Borland, 2001).

In addition to the pressure to conform, the need for optimal distinctiveness has also been linked to the desire for group members to improve the overall status of the in-group (Dawes, van de Kragt, & Orbell, 1988). This manifests in a number of cognitive and behavioral effects, including perceptual biases favoring the ingroup (e.g. Beaupré & Hess, 2002; Joseph, Weatherhall, & Stringer, 1997; Tajfel, Billig, Bundy & Flament, 1971) and participation in group-serving interests (Frey & Bohnet, 1997; Klandermans, Sabucedo, Rodriguez, & de Weerd, 2002). Within the social dilemmas literature, multiple studies have shown that those who are identified with a group tend to free ride less and donate more to support a public good (e.g. Brewer & Schneider, 1990; Simon et al., 1998; De Weerd & Klandermans, 1999). There is also evidence that this process is related to environmental attitudes and behavior. Those who are identified with a specific place, organization, or geographically-oriented community tend to support environmental initiatives that promote a positive image of that group or location, such as the establishment of government-protected land (Carrus, Banaiuto, & Bonnes, 2005). Interestingly, this effect was found after controlling for a measure of environmental concern and general support for the establishment of protected areas. In another study, Uzzell and colleagues demonstrated that identification with one's community positively predicted self-reported pro-environmental behaviors, such as energy conservation and the purchase of "green" products (Uzzell, Pol, & Badenas, 2002). Based on this literature, strength of identity would be expected to both moderate the effect of norms on behavior, as well as to exert a direct influence on conservation behaviors that are perceived to be beneficial for one's identity group.

Interventions

Based on the literature review presented above, two interventions were designed to encourage the reduction of electricity consumption in a workplace setting. The context in which these interventions took place, a large organization with many thousand employees, required a program that would be effective, relatively easy to implement on a large scale, and one that could reach a general audience. Furthermore, because workplace behavior is the target, individuals typically do not have access to data regarding their energy use and have no immediate financial incentive for reducing energy. These issues were taken into consideration when designing this campaign. The first of the two interventions, feedback, draws on expectancy-value theory and the behavioral reinforcement literature. The second, peer education, was designed to promote behavior change through the communication of social norms. Background research associated with each of these interventions, as well as predictions regarding their effectiveness, are presented below.

Feedback

Feedback refers to the process of returning a portion of an output back to the input, therefore allowing actors to become more immediately aware of their behavior and its consequences. Early research into human learning and achievement indicated that informational feedback improved the rate and level of learning new tasks (Ammons, 1956), the motivation to perform a task (Locke, Cartledge, & Koeppel, 1968), as well as the level of performance that was achieved (Ammons, 1956). These findings have been interpreted in light of theories of behavioral reinforcement such as Thorndike's (1927) law of effect and B.F. Skinner's (1938) principle of operant conditioning. Simply put, actions that bring about more positive experiences than negative ones are likely to be repeated again. Traditionally, this literature has involved the use of objectively positive or negative stimuli, such as the physical experience of pain or pleasure. In the present context, there is nothing inherently painful or pleasurable about the experience of reducing one's energy demands. Rather, the level of positive or negative reinforcement that is experienced is contingent upon the individual's pre-existing goals regarding energy use (Locke & Latham, 2002; Kluger & DeNisi, 1996). As such, feedback that indicates one's level of performance is consistent with a previously-stated goal will be experienced positively, whereas a performance-goal discrepancy will be perceived negatively.

Based on expectancy-value theories of behavior, feedback should be successful at promoting behavior change because it provides information regarding the extent to which one's behaviors are effective at achieving a valued outcome. Thus, it is expected that positive reinforcement will motivate individuals to continue or exaggerate recent behaviors, while negative reinforcement will motivate an individual to modify one's behavior. Furthermore, the effect of feedback on behavior should be mediated by an individual's outcome expectancy associated with that behavior, that is, the extent to which an individual believes his or her actions will bring about a certain outcome. The literature on feedback interventions provides compelling evidence for their effectiveness in promoting pro-environmental behavior. For example, in one of the earliest of these studies, Seligman and Darley (1977) presented a group of households with daily feedback regarding the amount of energy that was used during the previous day. During the four-week intervention period, those who received feedback used 11% less energy than households in the control group, who only received information about how to reduce energy (identical information was also received by the treatment group). Seligman and Darley's design has been replicated a number of times, resulting in declines in energy use generally ranging between 0 and 20% relative to controls and/or baseline (e.g. Benders, Kok, Moll, Wiersma, & Noorman, 2006; EPRI, 2009; McClelland & Cook, 1980; Sexton, Johnson & Konakayama, 1987).

While these effects are consistent with the predictions based on goal-expectancy hypotheses, little has been done to understand the mechanism by which feedback is effective in this context (Abrahamse et al., 2005). There is some evidence that feedback targets expectancy-related beliefs in other domains. For example, the relation between feedback and self-efficacy has been established in the fields of health psychology and organizational behavior (e.g. Hu, Motl, McAuley, & Konopack, 2007; Tolli & Schmidt, 2008). In some cases, self-efficacy beliefs (i.e. the belief that one's ability to succeed in performing a task) may be directly analogous to task outcomes. However, in the present context, this is not the case. Although related, the belief that one can succeed in performing a task is conceptually distinct from the the belief that this task, if successful, will lead to a desired outcome. To date, there are no known studies that have examined the effect of feedback specifically on outcome expectancy.

The work that has been done has unveiled a number of important factors that appear to moderate the effectiveness of feedback interventions. Perhaps the most critical factor is the individual's personal goals regarding the target behavior. As discussed earlier, feedback is only effective to the extent to which it communicates information regarding an individual's standing relative to some goal. Surprisingly, this point has been neglected in much of the work in this area. In most studies, participants' desires to save energy, water, etc. have either been assumed or overlooked. In fact, there is reason to believe that the majority of participants do endorse the goal of reducing their environmental impact, at least in the abstract. In national polls roughly 55% of Americans identify themselves as environmentalists[1] and over 61% report being personally worried about climate change.[2] This trend may explain why the effects of feedback have consistently been found, even within studies that do not measure or manipulate goals. However, there is evidence to suggest that in the absence of a goal to conserve energy feedback is ineffective. Becker (1978) experimentally manipulated this factor by asking participants to commit to a goal of reducing energy use by either 2% (easy goal) or 20% (difficult goal). In an additional control condition, no goal was mentioned to participants. Half of the participants in each condition were also exposed to feedback about their energy use three times a week. The results indicated that the difficult goal X feedback condition was the only group to significantly reduce their energy use. McCalley and Midden (2002) have replicated this effect while also showing that goals set artificially by the experimenter or by the participant were equally as effective as long as a goal was set.

There is also reason to expect that the success of feedback will be impacted by the level of specificity of the information that is provided. Specificity is a function of both the frequency with which feedback is received, including the number of actions that are represented by that feedback, as well as the unit of analysis, whether that be an individual, household or group such as a dormitory or office building. First, regarding frequency, there is some evidence that feedback is more effective when it is administered more often. The use of continuous feedback (generally presented using an electronic

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[1]Survey by Nuclear Energy Institute and Bisconti Research and Gfk NOP, April 10-April 13, 2008.

[2]Survey by Committee of 100 and Zogby International, August 20-September 4, 2007.

meter that tracks and displays the amount of a resource that is being used in real time) has been associated with some of the largest effects in this literature (for review, see Abrahamse et al., 2005). Van Houwelingen & Van Raaij (1989) compared feedback that was presented continuously or monthly and found that both were associated with significant reductions in natural gas use, although continuous feedback was more effective (12% reduction compared to 8% in monthly feedback group). Petersen and colleagues also compared continuous feedback to weekly feedback in reducing energy consumption and found that, while weekly feedback resulted in enormous savings (31%), continuous feedback was even more effective, leading to a 55% reduction in consumption (Petersen, Shunturov, Janda, Platt, & Weinberger, 2007). Other work has suggested there may be a linear relation between time interval and behavior change; however, this is speculative as there is no work to date that has compared more than two time intervals within the same study (for review, see Abrahamse et al., 2005). It is important to note that even relatively infrequent feedback reports, such as those given weekly, monthly, or even bimonthly, have been associated with both significant and substantial behavior change (e.g. Abrahamse, Steg, Vlek & Rothengatter, 2007; Van Houwelingen & Van Raaij, 1989). At this point, there is no evidence of a threshold effect for how often feedback must be administered before it is effective. As such, it appears that any amount of feedback is more effective than none at all.

The role of group size in feedback manipulations is less clear. Theoretically, the more individualized feedback is the more effective it should be because it provides more direct and useful information regarding an individual's behavior. Despite these results, interventions that have employed group-level feedback techniques to modify environmentally-significant behavior have had some success. In one notable example, Rothstein (1980) evaluated a program in a mid-sized U.S. city in which feedback was administered through the local news to reduce gasoline consumption. The study involved an ABABA design with alternating baseline (A) and intervention (B) periods. During this time, local gas stations reported fuel-consumption to the local television channel which, in turn, graphically presented these data on the local evening news. Results indicated that fuel consumption decreased by roughly 30% relative to the initial baseline. There was some evidence that gas use increased again when feedback was suspended between and after the intervention phases, although it remained significantly below baseline throughout the duration of the study. In a related study, Petersen et al. (2007) used group-level feedback in their intervention to reduce electricity use in dorms, which resulted in a 30 to 55% drop in consumption. Interestingly, Petersen et al. also varied the size of the group that was referenced by this information. In one condition feedback was disseminated for the entire dormitory, in another condition it was given only for specific floors within the dorm. The size of the group had no effect on behavior in this context.

While the literature on feedback interventions is promising, there are a number of holes that remain in this body of work. First, as discussed above, little had been done to examine the mechanisms by which feedback is effective at motivating behavior change. Second, there is some question as to whether feedback can be realistically incorporated into large-scale behavioral interventions, particularly in an organizational setting such as a business or university. The majority of work in this area has used feedback administered at the level of the individual or small group, typically targeting household energy consumption. While effective, many institutions do not have the resources to implement or maintain an intervention at this level of specificity. For example, organizations may have access to kWh data for individual office buildings, but rarely for individual offices or floors. In these settings, the number of kWh used may reflect the behavior of dozens or even hundreds of individuals. It would be costly and unrealistic to provide individual or small-group feedback in these cases. Thus, there is a need for additional research to examine the effectiveness of feedback administered to large groups such as those working in an office building.

There are additional questions as to whether feedback will be effective among individuals who are not financially responsible for the amount of energy they consume. The work of Petersen and colleagues (2007) suggests that feedback can be effective even when no economic incentives are present. However, this research took place within a dormitory setting at an historically liberal and environmentally-progressive institution (Oberlin College) and, therefore, its generalizability has been questioned. Likewise, the degree of behavior change that was observed (30 to 55%) is well beyond the range that has typically been seen in this line of research, which may suggest it is an anomaly. Additional work is needed to investigate whether feedback can be successful in motivating behavior change among a more diverse sample of adults when no financial incentives are present.

Peer Education

Much of what we know about peer education interventions within the context of pro-environmental behavior comes from the use of "block-leaders" to promote recycling. Block leader interventions use an individual currently living within a neighborhood to disseminate information about recycling, and to encourage participation in the program. While relatively few studies have examined this approach, the work that has been done indicates that information disseminated through block leaders is more effective than that coming from an unknown third party. For example, Burn (1991) compared groups of households who received information about recycling from either a block leader or from an experimenter who left the information by the door. Roughly 28% of those in the block leader group recycled weekly, compared to 12% of those in the information-only group. Other studies have replicated this finding (Hopper & Nielsen, 1991; Nielsen & Ellington, 1983).

In other domains outside of the context of environmental behavior, the use of peer educators have also shown promising results. For example, HIV prevention programs that are administered through peers (i.e. fellow students) have been found to be more effective than traditional educational approaches at promoting knowledge and reducing at-risk behaviors for some students (e.g. Mellanby, Phelps, Crichton, & Tripp, 1995; Merakou & Kourea-Kremastinou, 2006; Stephenson, et al., 2004). Similar interventions have used "opinion leaders" to reduce high-risk behaviors for the transmission of HIV (e.g. Kelly, et al., 1991; Stevens, Leybas-Amedia, Bourdeau, McMichael, & Nyitray, 2006). In a series of studies, popular members of the gay community in three small U.S. cities were asked to communicate casually during conversations with friends that it is socially desirable to reduce high-risk behaviors. Cross-sectional surveys revealed a decline in high risk behaviors among homosexual men in each of these three cities, while no changes were observed in comparison cities (Kelly, et al., 1991; 1992). A second randomized, controlled intervention involving eight U.S. cities replicated these effects using longitudinal surveys conducted one year apart. Results showed that, among other indicators, the number of men who reported engaging in unprotected sex declined by nearly 12% in the intervention cities, yet remained stable in the control cities (Kelly et al., 1997).

Multiple interpretations have been offered to explain the effectiveness of peer educators and opinion leaders. In one line of thinking, this approach is effective because peers are better able to capture the attention of their audience, and are perceived to be more trustworthy than an unknown third party who, in the context of environmental interventions, is often affiliated with a government or non-profit organization (Stern & Aronson, 1984). There is some evidence to support this claim. For example, others who are viewed as similar to oneself are often perceived as more credible, and there is evidence to suggest individuals are more likely to attend to information coming from a peer rather than an unknown source (Buller, Young, Fisher & Maloy, 2007; Costanzo et al., 1986). However, there appears to be an additional mechanism by which peers exert an influence via the communication of social norms. By using peers to encourage behavior change, in addition to providing the necessary information, these individuals may also be communicating the message that “other people in our group approve of this” (i.e.

injunctive norm) as well as "other people in our group are doing this" (i.e. descriptive norm).

While multiple authors have drawn on this explanation in their justification of peer educator interventions (e.g. Burn, 1991; Kelly et al. 1997; Stevens et al, 2006), few have empirically examined it as an explanatory process. An exception is Hopper and Nielson's work (1991) in which they measured both social and personal norms through longitudinal surveys administered to households in a block leader or information-only intervention to promote recycling. Their results indicated that only those in the block leader condition showed an increase in a perceived social norm for recycling from baseline to follow-up. They also showed that social norms predicted recycling behavior; however, the authors failed to test whether the effect of peer education was mediated by the presence of a social norm. Furthermore, Hopper and Nielson measured social norms as the extent to which an individual expects friends and neighbors to recycle, and vice-versa. It is questionable whether these items measure an injunctive norm or descriptive norm, or both. An open question is whether peer education operates through the communication of what is expected by one's peers, or what is done by one's peers. The work of Reno, Cialdini, and Kallgren (1993) suggests that by targeting both descriptive and injunctive norms simultaneously, an intervention may be more successful than by targeting only one or the other. A study employing a previously-validated measure of social norms that discriminates between injunctive and descriptive perceptions would be equipped to address this issue.

Currently, there are no known applications of peer education to the context of electricity conservation. There is reason to believe this approach would be effective within the context of an organizational setting, where individuals have regular social contact with one another and one's behavior can be easily observed throughout the workplace on a day-to-day basis. Furthermore, it has been shown that block leaders are more effective than economic incentives at promoting recycling, making it an attractive approach in a setting where individuals have no direct financial incentive to conserve (Meneses & Palacio, 2003/2004).

Predictions

As will be discussed in more detail below, the effectiveness of feedback and peer education were evaluated using a 2X2 cluster randomized field experiment in which a set of buildings were randomly assigned to treatment conditions. All buildings in the sample received the same basic information campaign to educate occupants about energy conservation and best practices for reducing energy use. One set of buildings received only this intervention, a second set of buildings received this campaign in addition to the feedback intervention, a third set of buildings received the information campaign as well as the peer education intervention and the final set of buildings received all three interventions. In all conditions, conservation behavior and actual energy use during the intervention were compared to baseline levels to assess change over time. Differences between groups were tested to assess the differential and combined effectiveness of the feedback and peer education treatments.

Based on the body of research discussed above, in Hypotheses 1 and 2 it was predicted that buildings assigned to receive the feedback and peer education interventions, respectively, would use less energy relative to baseline than those assigned to receive the information campaign alone. In addition to these core hypotheses regarding the effects of the interventions on energy consumption, a number of hypotheses were also made to describe the psychological mechanisms by which these interventions would be effective. Drawing on the expectancy-value and behavioral reinforcement literatures, the effect of feedback on individual conservation behavior should be mediated by outcome expectancy beliefs, operationalized as the extent to which an individual believes that his or her behavior will have an impact on the organization's overall level of consumption (Hypothesis 3). Furthermore, expectancy-value theory suggests that outcome expectancy beliefs alone are not enough to motivate behavior change, but an individual must also desire to achieve the outcome in question. For this reason, a moderating effect of conservation goal is also predicted. More specifically, it is expected that the strength of the relation between outcome expectancy and conservation behavior would be positively related to the strength of one's conservation goal (Hypothesis 4). The mediating and moderating effects outlined in these hypotheses are presented in Figure 1.

Although there are no known studies that have examined the effectiveness of peer education within the context of an energy conservation intervention, work from other behavioral domains suggests that messages delivered by a peer may be effective in communicating both descriptive and injunctive norms regarding energy use. Thus, it was predicted that the effect of peer education on conservation behavior would be partially mediated by the perception of both descriptive (Hypothesis 5) and injunctive (Hypothesis 6) norms. Currently, there is no evidence to suggest that peer education would selectively affect one set of norms more so than the other. However, given the nature of this intervention which involves the dissemination of information about a desirable behavior rather than summary information about how the group is behaving, it is plausible to expect it to have a greater effect on injunctive norms than descriptive norms. While no specific predictions were made, this issue was also explored in the analyses.

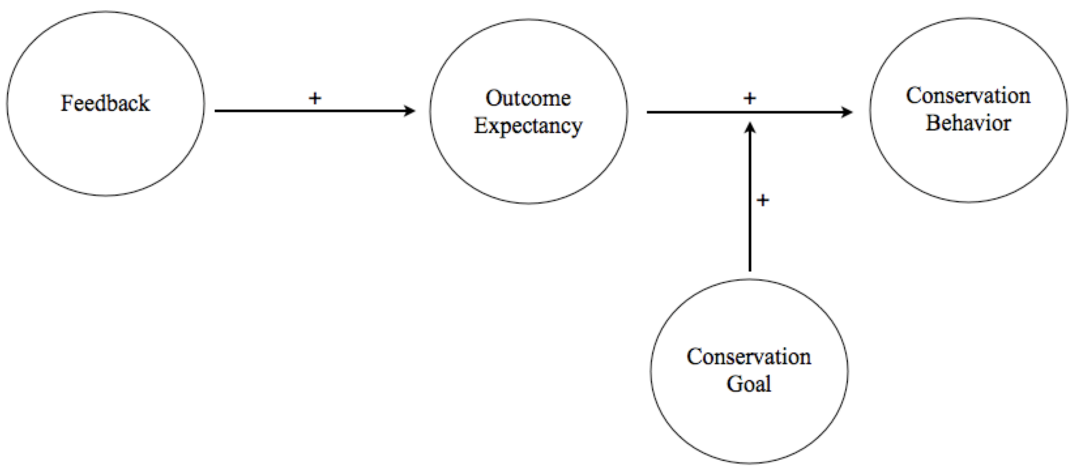

Figure 1. Causal model as predicted in Hypotheses 3 and 4 including the role of outcome expectancy in mediating the effect of feedback on conservation behavior (Hypothesis 3), and the moderating influence of conservation goal which is expected to amplify the effect of outcome expectancy on conservation behavior (Hypothesis 4).

In addition to the proposed mediating effect of norms, there is also reason to expect the effects of peer education to be moderated by the individual's level of identification with the organization. Based on literature suggesting that a salient social identity amplifies the motivation to conform to group norms and ideals (e.g. Schofield et al., 2001; Stürmer et al., 2003), it was expected that the effect of descriptive and injunctive norms on conservation behavior would be greater among those who have a strong organizational identity (Hypotheses 7 and 8). Likewise, a direct and positive effect of identity on conservation behavior was also expected (Hypothesis 9) based on the principal of optimal distinctiveness, which suggests that a salient social identity motivates behaviors that promote a positive group image. The causal structure outlined in Hypotheses 5 - 9 is portrayed in Figure 2.

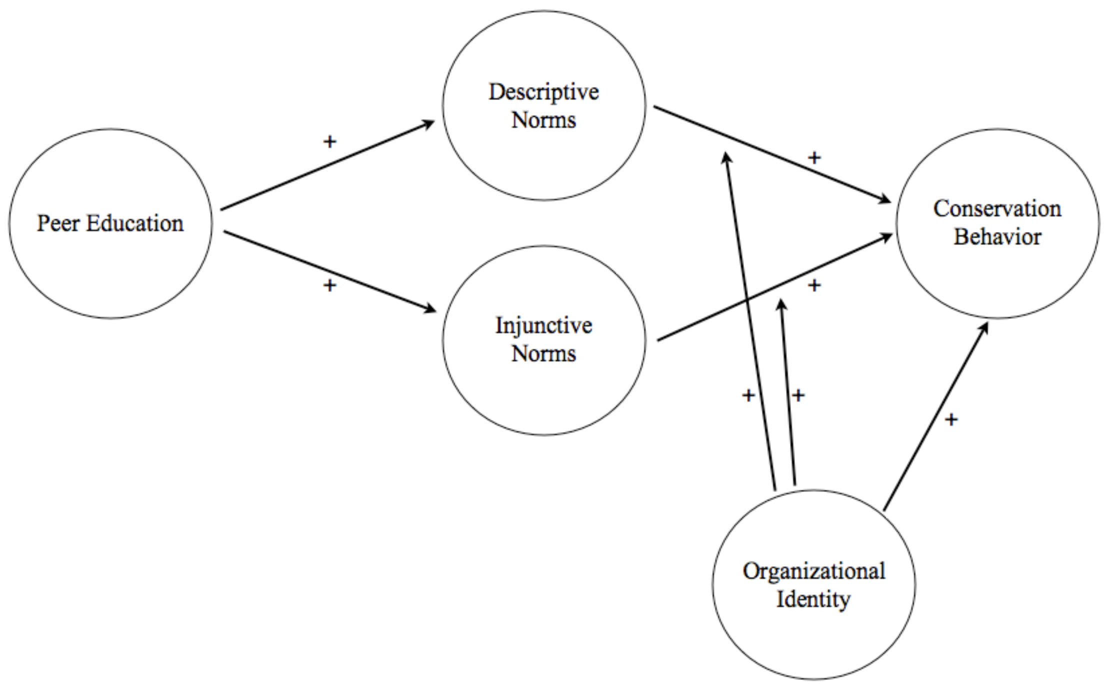

Figure 2. Causal model as predicted in Hypotheses 5 - 9. It is expected that descriptive and injunctive norms will mediate the effect of peer education on conservation behavior (Hypotheses 5 and 6), and that the relation of norms on behavior will be amplified among individuals who endorse a strong organizational identity (Hypotheses 7 and 8). A direct effect of organizational identity on conservation behavior is also expected (Hypothesis 9).

In addition to the predictions made about each intervention independently, there is also reason to expect that exposure to both interventions simultaneously would result in greater energy savings than either intervention alone. As discussed earlier, the work of Simon and colleagues (Simon et al. 1998; Stürmer et al., 2003; Stürmer & Simon, 2004) suggest there are two pathways for participation in social movement activities, the first involves a rational thought process in which prospective participants weigh the potential costs and benefits along with the expectation that these benefits will be realized. The second pathway is one that is motivated by a salient social identity, in which there is a desire to be seen as a "good" group member and to improve the status of the group. The dual-pathway hypothesis has been supported in this context with data indicating that the expectancy-value and social identity hypotheses were statistically independent from one another, and that both contributed unique variance to the prediction of movement participation (Simon et al. 1998; Stürmer et al., 2003; Stürmer & Simon, 2004). Furthermore, Stürmer et al. (2003) found that the two pathways produced an additive effect, rather than an interaction effect, on willingness to participate.

Although the present study applies this logic to a new domain, there is reason to expect motivations to operate in a similar fashion within the context of a pro-environmental intervention. It is feasible to expect that individuals who are exposed to both interventions will be more highly motivated to change behavior because they are being influenced both by social norms and identity processes, as well as by an increased sense of outcome expectancy. Likewise, individual differences in strength of identity or environmental attitudes may predispose some individuals to respond more favorably to one intervention more-so than the other. As a result, it was predicted in Hypothesis 10 that the number of individuals motivated to change their behaviors might also increase in the feedback + peer education condition, resulting in a greater overall decrease in electricity consumption per building from baseline to follow-up.

CHAPTER II

METHODS

Overview of Design

To determine the effectiveness of each intervention, as well as their combined effect, this study involved a 2X2 (feedback X peer education) factorial design within a cluster-randomized field experiment. The clusters were buildings used primarily for office space, research and teaching, and were located at a mid-sized private university in the southern United States. All study groups were exposed to the same basic information campaign in which they were educated about energy use and how to conserve energy (e.g., turning off lights, adjusting thermostats, etc). One-fourth of the sample received only this public information campaign and were, therefore, considered a control group. In addition to the public information campaign, a second set of buildings received the feedback intervention, a third set received the peer education intervention, and a fourth set of buildings received a combined intervention of both feedback and peer education (combined). All interventions were run simultaneously beginning the first week of September and continuing for a period of 14 weeks.

The interventions were evaluated using a combination of electricity data, behavioral observation, and surveys. The electricity data was recorded for a period of eight months including four months prior to the start of the intervention and the four months during which the intervention was active. Historical energy use data from the same eight-month period during the previous two years were also examined. Behavioral observations included a series of seven energy audits in which a researcher observed evidence of conservation behavior in the form of turning off unused lights and office equipment. Two of these observations were held prior to the start of the intervention to establish a baseline and the remaining five audits were conducted during the intervention. Finally, building occupants were also invited to participate in a series of two surveys. The first baseline survey was conducted just prior to the start of the campaign and the second follow-up survey occurred directly after the final intervention materials were disseminated. These surveys measured exposure to the interventions, self-reported conservation behavior, as well as a number of potential mediating and moderating variables (e.g., perceived social norms, outcome expectancy, organizational identity).

Sample Description

Buildings

Twenty-four buildings were included in this study. Buildings were eligible for inclusion if their electricity consumption was managed by the university and if they were used primarily for office space, research and/or teaching.[3] Of the 27 buildings that were considered eligible, two were excluded because they were scheduled to undergo large-scale renovations at some point during the intervention. A third building, used exclusively for administrative purposes, was not available for observation and was, therefore,

[3] Because residence halls were targeted in a separate energy conservation intervention, they were excluded from this study. Buildings that housed patient care facilities were excluded due to the specific energy needs of these buildings and concerns regarding patient privacy (specifically with respect to behavioral observations). Likewise, buildings that held medical or basic scientific research facilities were also excluded because the information campaign was not designed to address the conservation practices specific to these spaces, such as the use of biomedical imaging equipment, fume hoods, etc.

considered ineligible. The 24 buildings that were included in the sample varied widely in size and number of occupants. An estimated total of 2300 faculty, staff and students worked in these buildings and were exposed to the intervention. The number of occupants per building ranged from 15 to 290, with the average building hosting 88 ($SD = 60.2$) employees or graduate/professional students. Building size measured in square feet ranged from 11,571 to 180,258 ($M = 65{,}518$, $SD = 42{,}247$). There were no differences across intervention groups in average building size and the average number of occupants within each building.

Survey participants

Invitations to participate in the survey portion of the study were sent to 2,056 individuals who held an office or work space within one of the 24 buildings in the sample, and whose e-mails were available through their department's directory. Responses to the baseline invitation were received from 595 individuals for an initial response rate of 29%. Of those who responded to the initial survey, 59% ($n = 352$) completed the follow-up survey. The majority of respondents (73%, $n = 257$) were female. The mean age was 43 years and, as expected with an academic institution, this sample was highly educated with a median education level of "some graduate school." The majority of respondents (59%) were staff, 28% indicated that they were faculty members, and the minority (13%) were graduate students.

Little is known about the demographic characteristics of the target population with which to assess the representativeness of this sample. Demographic information is available for the student body; however, only a small and non-representative subset of the student body (i.e., those enrolled in a select number of programs that provide offices for graduate and professional students) was included in the target population. It is known that, among the employees within the target population (i.e., faculty and staff), 24% are faculty and 76% are staff. In the present sample, 32% of employees were faculty and 68% were staff, suggesting that faculty members may be somewhat over-represented (and staff under-represented) in this sample.

Demographic information for each of the four intervention groups is presented in Table 1. The four groups were roughly equivalent with respect to sex, age and education, and there were no significant differences between groups on these variables. There was a significant difference across intervention groups in the ratio of faculty, staff and students in the sample, χ^2 (6, N = 352) =19.05, $p < .01$. A larger proportion of staff (and a smaller proportion of students) completed the survey in the control and combined groups than in the feedback and peer education groups.

Table 1
Demographic Profile of Survey Respondents by Intervention Group.

	Control (n = 82)	Feedback (n = 90)	Peer Education (n = 98)	Combined (n = 72)
Sex (% female)	72%	72%	70%	79%
Age	43.7	43.2	42.4	41.6
Education	5.0	5.1	5.2	5.2
Position (%)				
Faculty	28%	31%	31%	21%
Staff	68%	47%	55%	70%
Student	4%	22%	15%	9%

Note. Value indicates mean score unless indicated otherwise.

Intervention Materials

Information campaign

The information campaign included a series of four postcards delivered to building occupants' mailboxes throughout the intervention. The front of each postcard featured an unique image related to energy use, as well as the campaign logo. The back of the postcard included a message about energy conservation (an example is provided in Appendix A). This information was designed to meet three criteria. First, postcards were intended to provide individuals with information about energy and why conservation is necessary. Second, it was intended to provide instructions on how energy can be saved in the workplace, focusing on specific target behaviors such as light use, thermostat settings, and computer use. Finally, it was designed to establish a goal for each building to reduce energy use by 15% or more. This goal was selected based on data suggesting that previous behavioral interventions targeting conservation behaviors (not including efficiency upgrades) have resulted in savings ranging from 0 to around 55%, most often falling within the range of 5 to 15% (e.g. Abrahamse et al., 2005; Petersen et al., 2007). Past efforts to reduce energy use within this organization during mandatory curtailment periods have resulted in savings of 8 to 12%. Craig and McCann (1978) argue that goals such as these should be both reachable and believable. However, Becker (1978) has shown that a challenging goal (i.e. 20%) is more effective than a simple goal (i.e. 2%), even though participants in the challenging goal condition achieved only a 13 - 15% reduction. Based on this literature, a goal of "15% or more" was selected because it is considered achievable, but exceeds past successes.

The first postcard, delivered during week 1 of the campaign, was designed to introduce the campaign, to inform participants of what to expect throughout the campaign, and to challenge them to reduce their energy use by 15% or more. The remaining three postcards reinforced this goal while targeting a different behavior each time (e.g. heating and cooling, light use, and appliance usage). These three postcards were delivered during weeks 4, 7, and 11 respectively.

Feedback

Those who were assigned to receive the feedback intervention received a monthly e-mail summarizing their building's energy use during the previous month. This presentation was designed to conform to the recommendations of Siero et al. (1996) and Benders et al. (2006), both of whom suggest that feedback of this kind should be designed to be both simple and concrete (Siero, Bakker, Dekker, & van den Burg, 1996). Likewise, they recommend including a temporal reference as well as a reference to any relevant target or goal. In the present study, the feedback presentation included a graphical display of the electricity used by each building since January of 2008 (see Appendix B). This display was updated monthly as additional data were recorded. The target range of a 15% or more reduction in energy use was shaded on the graph to allow the user to easily interpret where his or her building was relative to this goal.

Text was included below the graph to indicate the previous month's energy use in kilowatt hours of electricity, as well as the percent difference between this value and the typical level of energy use during that period of time. The text in these graphs was identical across buildings with two exceptions. First, when a building reduced its electricity use below that of previous years, the line “Keep up the good work!” was added to the text. Second, buildings that met their goal during the previous month also received the line, “You’ve met your goal of reducing energy use by 15% or more.” Buildings that remained stable or increased their energy use received no additional text. A web link was also provided in all feedback messages for participants who wanted to read additional information about the data, how the target range was set, and general information about the campaign.

This information was disseminated during the week after the energy data became available to provide the most immediate feedback possible. This occurred during weeks 2, 7, and 11 of the campaign. Individuals received feedback only for their own building, and did not have access to information about other buildings. The feedback was delivered by e-mail from a university e-mail address used strictly for issues related to sustainability, energy and the environment.

Peer Education

Prior to the start of the intervention, 15 individuals volunteered to serve as peer educators for the 12 buildings assigned to receive this treatment. This includes three educators in one building who volunteered to serve within their respective departments and two educators who jointly volunteered in a single building/department. The peer educators were comprised mostly of staff (n = 8), but also included graduate students (n = 6) and faculty (n = 1). The majority (n = 9) were women. The process of recruitment for these individuals is described in the procedure section below.

The primary responsibility of the peer educators was to send monthly e-mails, in addition to an initial introductory e-mail, to reinforce the messages included in the information campaign and to provide additional information or suggestions that were specific to that individual's building. The peer educators were encouraged to comment on actions they had observed within their own department regarding energy use, (i.e. "I have noticed many people turning off their lights during the day"), as well as specific actions that need to be taken (i.e. "the copier on the third floor is often left on over night"). The peer educators were provided with e-mail templates each month, which they could use and edit for their own messages. They also received resources and literature related to energy use and conservation. An example of a peer educator e-mail, which is considered prototypical for this intervention, is provided in Appendix C. The peer educators were instructed to copy the researcher in these e-mails to allow for a record of the program's implementation. Each educator was prompted to send their monthly e-mail directly after the postcards were delivered and, thus, were notified during weeks 1, 4, 7 and 11 of the intervention.

In addition to the monthly e-mails, the peer educators also served as a point of contact within their building or department on issues related to energy use. These questions or comments, which consisted almost entirely of maintenance requests to have inefficient equipment repaired, were then passed on to the appropriate individuals to arrange for a follow-up.

The majority of peer educators complied, at least partially, with the basic requests of sending monthly e-mails and serving as a point of contact. However, two individuals who volunteered prior to the start of the intervention did not initiate this campaign. In one case, the individual failed to follow-up to requests to schedule the orientation meeting. In a second case the individual did not respond to prompts to send the initial e-mail and later contacted the researcher to drop-out of the program citing “a lack of time” as the reason. Because replacements could not be found for these buildings, this intervention was never initiated in two of the 12 buildings assigned to receive it. Both buildings were assigned to the peer education group (rather than the combined condition). This issue will be discussed further from a methodological perspective within the results section.

Among the 13 educators who did initiate the campaign, there was some variance in the number of e-mails sent to their respective departments. The majority of educators ($n = 7$) sent three of the four e-mails requested by them. Only two educator sent all four messages, two educators sent two messages and two educators sent only one message to their departments. A minority of peer educators ($n = 4$) took steps to encourage energy conservation in addition to the monthly e-mails and serving as a point of contact. Although individuals were encouraged to incorporate their own ideas into the peer education program, these efforts were left up to them, with the team of researchers and university administrators serving as a resource when needed. Four individuals included or made the researchers aware of efforts that were in addition to the monthly e-mails. One individual organized an informational session within the department, a second arranged for signs to be posted within the building to remind occupants to power down shared equipment, a third facilitated an open forum within her department to discuss ideas for reducing energy use and a fourth arranged for high efficiency compact fluorescent light bulbs to be made available free of charge to the faculty and staff in his building. Measures have been created to account for differences among the peer educators in terms of the level of involvement, this is described in the measurement section below.

Evaluation Materials

Electricity use

Electricity consumption was measured monthly by the university in raw units of kilowatt hours (kWh), which is the standard unit of measurement, and were made available to this researcher upon request. Data were collected over the course of eight months including the four months prior to the start of the intervention and extending through the four months in which the intervention was active. Historical data from the previous two years during the same eight-month window were also provided. Kilowatt hours data were not available for one building due to a technical malfunction with the electricity meter that occurred one month prior to the intervention and could not be resolved before data collection was concluded. Data from this building was, therefore, omitted. Out of a total of 192 potential observations, 183 were available for analysis.

To adjust for large differences in the level of electricity consumption due to building size, raw kWh values for each building were divided by the total square feet for that building. After adjusting for building size, kWh/sqft consumption ranged from 0.47 to 4.74 kWh per square foot ($M = 1.61$, $SD = .92$). These adjusted values were used in all analyses reported below involving kWh consumption.

Temperature

The average monthly temperature for each of the eight months included in the analysis was calculated based on local readings collected by the National Weather Service. So as to reflect the level of demand for energy associated with heating and cooling, this information was re-coded as the absolute difference between the average monthly temperature and 65^{o}F. This is a widely accepted reference point for assessing heating and cooling demand (i.e., "degree days") because it is assumed that when outside temperature reaches 65^{o}F no heating or cooling is required (National Weather Service, 2005).

Observed conservation behavior.

Seven energy audits were performed in each building to document evidence of conservation behavior in the form of turning off lights and equipment. This includes two baseline audits and five audits that were conducted during the intervention. A series of judgements were made for each room or space that was observed (described in more detail below). For spaces that could not be observed, or where specific judgements could not be made, entries were left blank. For any given audit there were, generally, a large proportion of rooms that could not be observed and, therefore, a substantial amount of missing data. Furthermore, whether or not a room could be observed varied over time depending on the time of day the audit was conducted, course schedules, and a number of other factors outside of the researchers control. To facilitate interpretation, as well as to compensate for the large number of missing observations, these data were aggregated to the level of the building. In other words, for each audit a percentage was calculated to represent the proportion of lights turned off in occupied rooms in that building. Percentages were also calculated for the proportion of lights turned off in *un*occupied rooms, and the proportion of unused equipment (e.g., monitors, audio/visual equipment, etc.) turned off. These measures are discussed in more detail below.

Room information. For each room or space that was observed, the auditor indicated the purpose of that room (e.g., classroom, bathroom, mailroom, lab space, etc.), and whether that space was occupied at time of measurement. Hallways and foyers were excluded from analysis for a number of reasons. In some buildings switches for hallway lights were controlled centrally and, therefore, building occupants did not have access to the switches to turn these lights off when they were not in use. Furthermore, many buildings required some or all lights to be left on for safety and security purposes.

Lights. To measure the frequency with which unused lights were turned off, two pieces of information were recorded for each space that was observed: the total number of light switches available in the room, and the total number of light switches that were turned off at the time of measurement. In cases where the total number of lights could not be counted, such as in an occupied classroom or inaccessible office space, a 1 was entered for this data point. In these cases, if it appeared that all lights in the room were turned off at the time, a 0 was entered for the number of lights turned off. If some lights were turned off but others were left on, 0.5 was entered, and a 1 was entered if it appeared that all lights were on at the time of measurement. Two indicators of conservation behavior were derived from these data. The first was the proportion of all lights in unoccupied rooms that were turned off and the second was the proportion of all lights in occupied rooms that were turned off. As such, higher values on each indicated a higher degree of conservation behavior. Motion-sensor lighting were excluded from these calculations.

Equipment use. Similar measures were calculated for the use of equipment in offices and classrooms, such as printers, computer monitors, projectors, etc. Because multiple buildings within the study sample require computers to be left on through the night, computer towers were not included in this measure. For each room that was observed, the total number of equipment pieces was recorded as was the number of pieces that were turned off at the time of measurement. Information was recorded only for equipment in which there was an on/off switch. For example, in some cases media equipment was connected through a single on/off switch and this was recorded as a single piece of equipment. Based on these data, a figure was calculated for the proportion of all equipment in unoccupied rooms that was turned off at the time of measurement.

Surveys

Participants responded to two surveys over the course of the study including an initial baseline survey and a second follow-up survey during the final weeks of the intervention. For the majority of behavioral measures, respondents were asked to report the frequency of their behaviors during the previous five-day work week. Participants also indicated the total number of days they worked in their office during this time period. Exceptions to this are noted below. All items are included in Appendix D.

Demographic information. In the baseline survey participants reported their sex, age, and education. In addition to this general demographic information, participants also indicated what building and department they worked in, how many years they had been associated with the organization, and their primary role at the university (i.e., faculty, staff, or student).

Computer use. To measure energy conservation associated with computer use, participants were asked to report if they currently had the energy saving settings on their computer turned on. Those who reported that they did were scored as a "1" and those who said they did not or weren't sure were coded as a "0". Next, participants were asked to report how many times during the previous work week that they turned off/hibernated their computer, turned off their monitor and turned off their printer before leaving work for the day. These values were coded as the percentage of the time each action was taken out of the total number of days the individual had worked that week. The four values were averaged to create a single index of computer-related conservation behavior.

Light use. Participants reported the number of days during the previous work week in which they turned off their office or desk lights before leaving work for the day. This value was re-coded as the percentage of days in which the light was turned off out of the total days that individual reported working during the previous week. Participants also reported how often they turned off their lights before leaving for an extended period of time, such as to go to lunch or attend a meeting. Response options included "almost never," "about 25% of the time," "about 50% of the time," "about 75% of the time" and "almost all the time." These entries were coded as the percentage of time that lights were turned off, with the values 5% and 95% inserted to represent the responses "almost never" and "nearly always." As such, the re-coded response options were 5%, 25%, 50%, 75% and 95% respectively. The two items were averaged to create an index of light use.

Thermostat use. Participants were also asked to indicate the proportion of time during the previous work week that they adjusted their thermostat to ensure that the heat or air conditioning would run less when they were not at work.

Office equipment. Participants were asked to report how often they turned off office equipment after they were finished using it. Responses were coded as the percentage of time that equipment was turned off, ranging from 5% to 95%.

Outcome expectancy. Outcome expectancy refers to the belief that one's behavior will lead to a certain outcome (Bandura, 1977). In the present context, this refers to the perception that one's personal decisions regarding energy use will lead to a decrease in the university's overall level of energy consumption. Four items related to the context of energy conservation were developed for this study (see Appendix D). Two negatively worded items were designed to assess the extent to which participants believe their behavior is negligible in the context of the university's overall energy consumption. The third item, which is positively worded, was created to asses the extent to which one's personal actions impact the university's energy use. The fourth item, also positively worded, assessed whether it is believed that the behavior of students and employees can reduce the university's energy consumption. All items used a five-point scale ranging from "disagree strongly" to "agree strongly."

Similar items were used by Steg et al. (2005) within the context of a national “energy problem” in The Netherlands. Steg et al. (2005) referred to this construct as “ascription of responsibility”, which was defined as the belief that one’s actions can reduce a problem (in this case, the energy problem). Conceptually, this is nearly identical to the definition of outcome expectancy used in this study. Steg et al. (2005) demonstrated that these items have good internal consistency (*alpha* = 0.80) as well as discriminant validity from other related constructs (e.g. awareness of the consequences, personal environmental norms). In the present study, *Cronbach's alpha* was 0.69 at baseline and 0.77 at follow-up.

Conservation goal. Four items were used to measure the extent to which participants endorsed a goal to conserve energy at both baseline and follow-up. The measure included three positively-worded and one negatively-worded items that referred to both personal energy use (i.e. “I would like to reduce the amount of energy that I personally use”), as well as the campus as a whole (i.e. “Vanderbilt should do more to save energy”). All responses were made on a five-point scale ranging from “disagree strongly” to “agree strongly,” with the negatively-worded item reverse-coded. An inter-item reliability analysis indicated that the four items had poor internal consistency at both baseline and follow-up (*Cronbach's alpha:* baseline =0.64, follow-up = 0.67). The inter-item correlations suggested that the one negatively-worded item was uncorrelated with the remaining three items. This item was dropped from the measure and the *Cronbach's alpha* for the three-item scale increased to 0.74 at baseline and 0.80 at follow-up.

Descriptive norm. Four items were used to measure descriptive norms for energy conservation, or the extent to which an individual believes other department members engage in various energy conservation practices. In both the baseline and follow-up surveys, participants were asked to indicate, to the best of their knowledge, how many individuals in their building engage in four conservation practices: powering down computers/monitors, turning off lights, adjusting thermostats, and turning off office/lab equipment. Response options included: very few, about 25%, about 50%, about 75%, and nearly everyone. These items were adapted from Ohtomo and Hirose's (2007) measure, which was previously used to study descriptive norms of recycling on a university campus. Ohtomo and Hirose demonstrated that this measure is sufficiently reliable, and has good discriminant validity in relation to other similar constructs, such as injunctive norms and environmental concern.

Injunctive norm. Four items were used to measure injunctive norms, or the perception of approval/disapproval of conservation behavior among the other individuals within the individual's building. These four items were, again, based on Ohtomo and Hirose's (2007) measure of injunctive norms for recycling, which was shown to be a reliable and valid measure of perceived injunctive norms. Participants were asked to report in four items how the people in their department would react if they saw a computer/monitor left on, lights left on, a thermostat was not adjusted, and office/lab equipment was left on. The response options included strongly disapprove, disapprove somewhat, neither approve nor disapprove, approve somewhat, strongly approve. These items were reverse coded such that a higher value indicated the perception that one's peers approve of steps to conserve energy.

Organizational identity. A six-item measure of organizational identity was borrowed from Mael and Ashforth (1992), e.g., "When someone criticizes Vanderbilt, it feels like a personal insult," "When I talk about the university, I usually say 'we' rather than 'they'." This measure is based on Tajfel and Turner's (1979) conceptualization of social identity and is defined by Mael and Ashforth as "the perception of oneness with or belongingness to an organization" (1992, p. 104). This is one of the most frequently used measures of organizational identity in the literature (for review, see Haslam, 2001, p 366), including identification with academic institutions (e.g. Mael & Ashforth, 1992; Bedeian, 2007). The internal consistency of this measure has been well-established (e.g. Cicero & Pierro, 2007; Kreiner & Ashforth, 2004; Mael & Ashforth, 1992), and it has been found to be statistically independent from other related constructs, such as organizational commitment and organizational citizenship behavior (Mael & Ashforth, 1992). In the present study *Cronbach's alpha* was .90 at baseline and .92 at follow-up. Response options ranged from 1 (strongly disagree) to 5 (strongly agree). The six items were averaged to create a single scale.

Measures of Implementation

Campaign exposure. To measure exposure to the information campaign, survey participants were asked to indicate whether they received printed materials through the mail and whether or not they read this material. Response options for the latter question included "no, I did not read them," "yes, I read some of it" and "yes, I read all or nearly all of it." Identical items were used to measure exposure to the peer education intervention (i.e., “Did you receive regular e-mails from someone from within your building or department...”) and the feedback intervention (i.e., “Did you receive graphs via e-mail displaying your building’s level of energy use?”). For each intervention, a single measure of exposure was created in which those who reported receiving nothing were coded as a “0”, those who received the materials but did not read them received a “1”, and those who read “some” or “nearly all” of the materials received values of “2” and “3” respectively.

Peer educator involvement. Unlike the other two interventions, the degree of implementation of the peer education treatment varied across buildings. Two variables were created to assess the extent to which the peer educator’s level of involvement in the program may have affected the results of the intervention. The first variable, labeled E-mails, recorded the number of department-wide e-mail contacts made by the educator (ranging from 0 to 4). In the one building where more than one educators sent e-mails, the mean number of e-mails sent by the three educators was used. The second variable (Extra) indicated whether the peer educator organized efforts within his or her department in addition to these e-mails. Those who did organize additional efforts received a one for this variable and those who did not received a zero.

Procedure

This study, including the baseline evaluation, took place over an 18-week period beginning in August of 2008 and concluding in December. This includes a four-week period of baseline evaluations and 14 weeks during which the intervention was ongoing.

Table 2 summarizes the chronology of events that took place over the course of the study, including the interventions and evaluation. The procedures for each component of this project are discussed in more detail below.

Random Assignment

The 24 buildings in the study were randomly assigned to one of four experimental groups. All buildings received the same basic public education campaign, designed by the university, to educate the community about energy consumption and best practices to conserve energy. Six buildings (one-fourth of the sample) were assigned to the control condition, in which they received only information from the public education campaign. An additional six buildings also received a feedback intervention, another six buildings also received a peer education intervention, and the remaining six buildings received both feedback and peer education, in addition to the public education campaign (combined).

Prior to assignment into groups, the 24 buildings were divided into three energy use strata based on their kilowatt hours consumption averaged across the six months prior to the study. An equal number of buildings from each strata were randomly assigned to each of the four conditions described above. Average kWh consumption during the six months prior was compared across treatment groups and no differences were found. There were also no significant differences with respect to building size and the number of building occupants.

Table 2

Chronology of Interventions and Data Collection

	Baseline				Intervention													
Week	-4	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14
INTERVENTION																		
Control																		
Information Campaign					PC1			PC2			PC3				PC4			
Feedback																		
Peer Education																		
Feedback																		
Information Campaign					PC1			PC2			PC3				PC4			
Feedback						FB1					FB2				FB3			
Peer Education																		
Peer Education																		
Information Campaign					PC1			PC2			PC3				PC4			
Feedback																		
Peer Education					PE1			PE2			PE3				PE4			
Combined																		
Information Campaign					PC1			PC2			PC3				PC4			
Feedback						FB1					FB2				FB3			
Peer Education					PE1			PE2			PE3				PE4			

Week	-4	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14
DATA COLLECTION																		
Survey			Survey 1													Survey 2		
Energy Audit	Audit 1			Audit 2		Audit 3			Audit 4			Audit 5			Audit 6			Audit 7
Kilowatt Hours	←	kWh 1- 4 ◆				kWh 5 ◆				kWh 6 ◆				kWh7 ◆				kWh8

PC = Postcard; FB = Feedback; PE = Peer Educator Message; kWh = Kilowatt Hours Reading

Information campaign

Postcards were disseminated during weeks 1, 4, 7 and 11 of the intervention. This information was hand-delivered to campus mailboxes by a research assistant.

Feedback

Once the kilowatt-hours for the previous month had been recorded, the feedback graphs and accompanying text was created by the experimenter and e-mailed directly to the individuals designated to receive this intervention. This occurred during weeks 2, 7, and 11.

Peer education

To recruit peer educators the researchers began by contacting individuals who had previously expressed an interest environmental issues on campus through their participation in campus events and organizations. A researcher contacted these individuals directly via e-mail to to gauge their interest in participating. For buildings in which no occupants were listed in the database, an individual within the administrative office was contacted for suggestions on who may be interested in volunteering and the researcher then contacted these individuals personally. At the end of the recruitment process, peer educators had been identified for all buildings assigned to receive this intervention. All educators freely volunteered to participate and no one was asked to participate by anyone other than the researcher (i.e. a supervisor or colleague).

After each individual had agreed to participate, the researcher met with the peer educators individually to explain the program in more detail and to provide him/her with a packet of information containing: (1) instructions and timeline of their responsibilities, (2) templates for the e-mails they were asked to send throughout the program, (3) a list of occupants and e-mail addresses for those in their building, (4) information about energy conservation and best practices for reducing energy use, and (5) contact information for the researchers, maintenance staff, and other key personnel.

At the start of the intervention, the peer educators were asked to send an initial e-mail to introduce themselves and to encourage their colleagues to contact them with any questions, comments or suggestions. Directly after each subsequent postcard was received, the peer educators were prompted to send an e-mail to reinforce the message highlighted in that postcard, to communicate what he or she had observed within the department, and to provide any updated information in response to questions or comments received during the previous month. Electronic copies of the e-mail templates provided in the information packet and the e-mail addresses of the building occupants were included in each e-mail prompt. Prompts were sent during weeks 1, 4, 7, and 11 directly after the postcards had been delivered for that week.

At the conclusion of the intervention each peer educator was presented with a gift bag and hand written note to thank them for their participation in the program, as well as an invitation to complete a brief follow-up survey about their experiences. In addition to providing feedback about the campaign and intervention overall, this survey was also designed to measure the peer educator's level of interest and involvement in the program. Because only five of the fifteen peer educators completed this follow-up survey, these data will not be discussed here. Instead, the two measures of level involvement described above will be used to assess this variable.

Behavioral observation

Behavioral observations in the form of energy audits were performed during alternating weeks throughout the study. This includes two baseline audits conducted before the intervention began and five audits that took place while the intervention was ongoing. All audits were performed during the work day, between 10am and 4pm Monday through Friday. No audits were performed on holidays. Because the organization sponsoring this campaign required that it be launched simultaneously with the start of the fall semester, one baseline audit was conducted before courses were in session while the second baseline and all intervention audits were conducted after courses had begun. Because there is no reason to believe that the start of the fall semester would affect some buildings or treatment groups more than others, this is not considered a confound for the purposes of evaluating the interventions relative to the control and to one another. However, it should be noted that baseline scores are likely to reflect the fact that there was less activity in these buildings during the baseline period.

The energy audits were carried out by three research assistants. Prior to the start of data collection, the researchers completed a series of training sessions in which they observed audits and performed practice audits in a subset of the study buildings. After completing the training sessions, the researcher completed a test audit in which he/she independently audited a set of offices and rooms that were set-up and previously coded by the principal investigator. Incorrect observations or discrepancies were discussed and resolved and the test was repeated. All researchers achieved 100% accuracy before data collection began. Each researcher was then assigned a set of buildings for which they were responsible throughout the course of the study. This allowed for more efficient and reliable audits for each building. The assignment of researchers to buildings was counter-balanced across treatment conditions and the researchers were blind to condition. During the course of the study one researcher resigned. Due to insufficient funding and the inability to train a replacement in a timely manner, a researcher who was not blind to condition completed the audits. No statistical differences were found between researchers, including the non-blind researcher.

Prior to the start of data collection, each building in the sample was mapped to record room numbers, the purpose of that room, and any equipment within the room that was to be measured. This was done to reduce the potential for error and to improve consistency in terms of what was observed. Information specific to each building was also recorded, such as the presence of motion-sensor lighting or unique office equipment. After this initial mapping was complete, researchers walked through their assigned buildings and recorded information about lights and equipment in each room using a clipboard. So as not to alert the building occupants to the fact that they were being observed, as well as to avoid interruptions, observations that could not be made unobtrusively (i.e. without interacting with the occupants in that room) were recorded as missing. Likewise, rooms that were closed at the time of the observation were marked as unobservable.

Surveys

Three weeks prior to the launch of the intervention, prospective survey participants were contacted by e-mail with an invitation to participate in an online survey about energy use on campus. Those who agreed to participate were instructed to use a link to complete the survey on a secure web-site. A unique link and associated random identification number was generated for each participant, allowing the researchers to anonymously track participation from baseline to follow-up. Those who did not wish to participate were instructed to follow an alternative link to remove their names from the database. Participants were given a total of ten days to respond to this survey. Those who did not respond to this initial e-mail by following one of the two links were contacted again five days following the initial e-mail to encourage a response and again 24 hours prior to the deadline. Those who participated in the initial baseline survey were contacted again during week 10, just after the final postcard was delivered. During this time participants were, again, given ten days to complete the online survey and were sent two reminders if no response was recorded. To encourage participation, a drawing was held after each survey for the chance to win one of five $100 gift cards to an online retail store.

CHAPTER III

RESULTS

Overview of Data Analysis

A series of multi-level regression models were used to estimate the effects of the intervention conditions on energy consumption and conservation behavior, as well as the psychological mechanisms associated with these behaviors. Multi-level models (MLM), also commonly referred to as linear mixed models, random-coefficient models and hierarchical linear models, have the capacity to model a variety of complex data structures, particularly those involving nested designs and longitudinal data. Furthermore, MLM's are superior to traditional repeated measures procedures in their ability to handle missing data, reduce biases associated with attrition, and maximize statistical power (Hedeker & Gibbons, 1997; Singer & Willet, 2003). In the present study, longitudinal data involving more than two time-points (i.e., the kWh and audit data) were analyzed using a series of random-intercept and random-coefficient models in which repeated measures were treated as multiple observations nested within subjects (i.e. buildings). Because the survey data include only two time points, these observations cannot be modeled as repeated measures.[4] Instead, baseline scores were treated as covariates, as in traditional ordinary least squares (OLS) regression, and a series of hierarchical linear models were used to account for the fact that individual respondents were nested within

[4] Typically in multi-level modeling, at least three time points are required to model change over time (e.g., Singer and Willett, 2003).

buildings.

All analyses reported here used full maximum likelihood estimation and allowed for an unstructured residual covariance matrix. This is based on Singer & Willet's (2003) recommendations, as well as the goodness of fit statistics from these data when comparing multiple covariance structures (e.g., compound symmetry, unstructured, toeplitz). Where appropriate, the proportion of variance explained was determined using an estimate of *pseudo* R^2, which is calculated by comparing the proportional reduction in residual variance between nested models (Singer and Willet, 2003). Effect sizes using the *Hedges's g* (*g*) formula are provided for analyses examining mean changes over time (Rosenthal, 1994). All analyses were conducted using the PROC Mixed procedures in SAS version 9.1.

As was discussed in Chapter II, the peer education intervention was never initiated in two of the buildings assigned to the peer education group. In both cases, replacements could not be found and these buildings ultimately received an intervention that was effectively identical to the control.[5] To preserve randomization, which is essential to experimental design, and to avoid the possibility of artifacts due to sub-sets of buildings self-selecting out of intervention groups, the primary analyses reported here were based on the intended treatment condition assigned to each building. Analyzing the data in this way provides a more realistic estimate of the effectiveness of future peer education interventions which, based on these results, are likely to be affected by peer educators dropping out. As a secondary analysis, these data were also analyzed based on

[5] With the exception of the two individuals who had agreed to serve as peer educators, no one in these two buildings were told that they were to receive the peer education intervention.

the intervention that was ultimately received by each building. As such, the two buildings that were assigned to receive the peer education intervention, but did not, were re-assigned to the control group and the analyses were re-run. This secondary set of analyses was intended to examine whether the presence or absence of group differences found in the *intent to treat* analyses were the result of the interventions themselves, or limitations associated with the implementation of the peer education intervention.

Implementation Check

As a preliminary analysis, an implementation check was conducted to confirm that the assigned intervention materials were received by the intended occupants. A series of two-level hierarchical linear models were used to compare the four groups on self-reported exposure to the information campaign, peer education and feedback interventions collected during the follow-up survey. Results from these analyses conformed to the pattern expected from a successfully implemented intervention.

Exposure to the information campaign did not differ across intervention groups, $F(3, 315) = 1.06$, $p = 0.36$. The average participant reported an exposure level of 1.72, indicating that they had received the material and read some, but not all, of it (values ranged from 0 = "did not receive" to 3 = "received and read nearly all of the material").

Those who were intended to receive the feedback intervention reported higher levels of exposure to feedback (feedback: $M = 2.18$, $SE = 0.12$; combined: $M = 2.16$, $SE = 0.14$) than those assigned to receive the control ($M = 0.03$, $SE = 0.11$) and peer education ($M = 0.03$, $SE = 0.14$) interventions. The feedback and combined intervention groups did not differ on this measure and, thus, the average level of exposure across all individuals who were intended to received feedback 2.16 (*SE* = 0.09), suggesting that the average respondent received the feedback graphs and read at least some of the material.

Finally, those who were assigned to receive the peer education (*M* = 2.03, *SE* = 0.14) and combined (*M* = 1.94, *SE* = 0.14) interventions reported higher levels of exposure to the peer education materials (i.e., peer educator e-mails) than those who were assigned to receive the control (*M* = 0.39, *SE* = 0.11) and feedback (*M* = 0.86, *SE* = 0.13) interventions. Not surprisingly, mean exposure in the peer education group increased when the two buildings that were intended to receive this intervention, but did not, were excluded from the analysis. The mean level of exposure for all buildings that received this treatment was 1.96 (*SE* = 0.11), suggesting that the average person within this group received the material and read some, but not all, of it. All mean comparisons reported above were significant at the $p < .05$ level.

The Effect of Intervention Condition on Energy Use

Kilowatt Hours Data

Kilowatt hours were collected over the course of eight months, including a four months of baseline data and four months during the intervention. Data for one building were excluded due to a meter malfunction that occurred during the intervention. Therefore, 184 observations were available for analysis. To account for differences in building size, raw kWh values were divided by the total square feet for that building. These adjusted values are used in all analyses reported below.

Outlier Analyses. Due to a large degree of variance between buildings in the kWh data, these data were screened for outliers within buildings. To do this, box plots for each building were visually inspected. Observations that fell beyond 1.5 times the inter-quartile range were flagged as potential outliers. This applied to seven observations in five buildings. Next, empirical growth models were examined to assess whether the large deviation between each potential outlier and the "normal" range of data for its building could be explained by an historical event, measurement error, or trend in kWh over time. One observation was uncharacteristically low (i.e. more than two standard deviations below the mean) for that building. This observation was also recorded during an historically high energy-use month while the observations directly before and after were within the normal range for those months. There is no known event that can account for this discrepancy and, therefore, it is believed that this observation represents a technical malfunction in the meter. For this reason, it was deleted from the sample.

The remaining six observations, although at the extreme ends of their distributions, did not appear to deviate from the typical pattern of energy use for those buildings. These observations were flagged and the subsequent analyses were estimated with and without the outliers included. The exclusion of these outliers had no effect on the results and, therefore, these cases are included in all analyses reported below.

Preliminary Analyses. Before running the primary analyses, baseline values of kWh consumption across treatment groups were examined. The analyses described below are, to a large extent, equipped to control for group differences at baseline; however, a group that significantly differs from the remaining groups may have a different capacity or trajectory of change due to this point of origin. In the present data there were no statistically significant differences in baseline values based on the intended treatment condition and no differences as a function of treatment received.

Prior to analysis, a series of initial models were run to estimate the degree of within- and between-building variance, as well as to examine the effects of the covariates. Results from a null model, which includes estimates for only the fixed and random intercepts as well as the error term, indicated there was a significant degree of both between- and within-building variance. The intraclass correlation coefficient was high (ρ = 0.94), indicating that 94% of the total variation in kWh consumption fell between buildings. Although the within-building variance over time was significant, the estimate was very small (< .001). This small degree of within-building variation can cause difficulty when attempting to estimate random effects of time, as is traditionally done when modeling longitudinal data with multi-level models. Furthermore, a visual examination of kWh values across time for each buildings suggested that, while there were large differences in mean kWh scores, the functional form of these values over time was highly consistent across buildings. Together this suggests that these data are best modelled using random-intercept regressions, which allows the intercept to vary across buildings, but estimates an average slope of time for all buildings (Cohen, Cohen, West, & Aiken, 2003; Singer & Willett, 2003).

To examine the effects of the covariates, historical kWh consumption from 2006 and 2007, as well as average monthly temperature during the baseline and intervention months, were entered both individually and simultaneously into a 2-level random intercept model. Not surprisingly, historical kWh use from 2006 and 2007 accounted for a significant proportion of variance in observed levels of consumption. Temperature was a significant predictor when entered into the model by itself; however, when entered simultaneously with historical kWh, this effect dropped out. This appeared to be due to the level of covariance between temperature and historical kWh. In other words, much of the variance in observed kWh consumption associated with temperature was already accounted for by historical kWh, which reflected a similar temperature pattern from when those data were produced. Because the temperature variable did not account for unique variance in the model, it was dropped from subsequent analyses.

Intent to treat analyses. The analyses presented below address two related but separate questions about the nature of change in kWh consumption over time. The first set of analyses examined mean changes from baseline to the intervention phase. This asks the question of whether there was an overall mean drop in kWh associated with the intervention and is most useful when estimating the level of behavior change in order to extrapolate cost savings or reductions in carbon dioxide (CO_2) emissions that can be achieved with a given intervention. The second set of analyses examine the trajectory of change over time to assess whether the intervention led to shifts in this trajectory. In other words, this analysis estimates whether energy consumption increased or declined at a steeper rate during the intervention as compared to baseline, and will provide some insight into whether the effectiveness of the interventions may have gradually increased or declined over time.

Table 3 presents the series of models used to estimate the effect of treatment condition on mean changes in kWh consumption. Model A presents the effects of the covariate model described above. To compare the average level of energy use during the baseline and intervention phases, a dummy coded variable (Phase) was created in which the baseline months were assigned values of zero and the intervention months were assigned values of one. This term was entered as a fixed effect into model B along with a four-level between-groups variable for the intended treatment condition (Group). The Phase X Group interaction term was added in Model C.

Table 3
Summary of Model Results Predicting Mean Changes in kWh Consumption from Baseline to Intervention.

	Model A			Model B			Model C		
	β	*F*	*p*	*β*	*F*	*p*	*β*	*F*	*p*
kWh 2006	0.32	15.59	< 0.01	0.36	20.19	< 0.01	0.33	16.63	< 0.01
kWh 2007	0.66	67.69	< 0.01	0.62	59.22	< 0.01	0.65	63.00	< 0.01
Phase				-	7.62	<.01	-	6.75	0.01
Group				-	0.49	0.70	-	0.45	0.72
Phase x Group								5.21	< 0.01

Note. Standardized parameter estimates (*β*) are presented for continuous variables only.

The results indicated a significant effect of Phase; however, this was qualified by a significant interaction effect. The adjusted means during the baseline and intervention phases for each of the four groups are presented in Figure 3. Planned contrasts revealed that kWh consumption remained stable in the control, $t(145) = 1.00$, $p = 0.32$, $g = 0.15$, and peer education, $t(145) = 0.78$, $p = 0.44$, $g = 0.12$ groups; however, declines were observed in the feedback, $t(145) = -2.20$, $p = 0.05$, $g = -0.28$ and combined $t(145) = -4.09$, $p < 0.01$, $g = -0.52$, groups. The pattern of means shown here also suggests that the combined intervention, which resulted in a 9% decrease in kWh consumption, may have been more effective than the feedback intervention, which produced a 5% drop. To assess whether these effects were different from one another, kWh consumption during the intervention phase was compared between the feedback and combined groups after controlling for historical kWh as well as baseline consumption. The result was non-significant, F (1, 29) = 0.06, p = 0.80, g = 0.04, suggesting that the two groups were not statistically different from one another. This analysis suggests that feedback was associated with a significant decline in energy use, yet peer education was not.

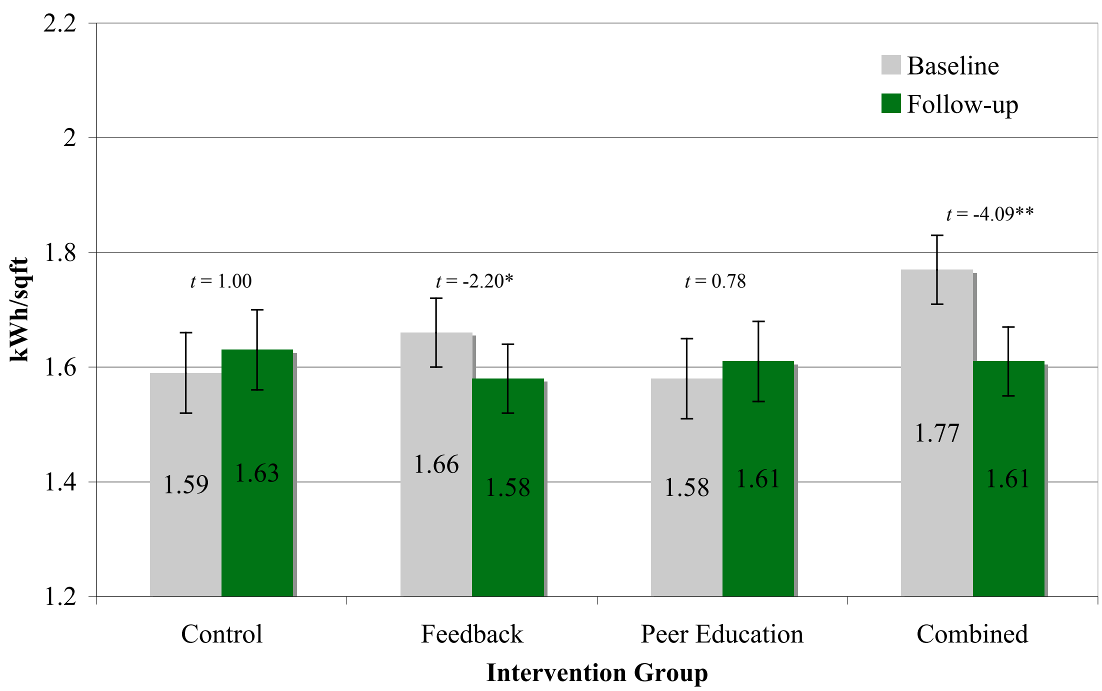

Figure 3. Mean differences in kWh consumption as a function of the intended treatment condition. Values are adjusted means after controlling for historical levels of kWh consumption.

The next series of analyses, summarized in Table 4, assessed group differences in the trajectory of change in energy use over the course of the intervention. In Model A, the mean-centered variable Time was entered as a predictor in addition to the covariates for historical energy consumption. In Model B, a re-coded variable for time (Time_Int) was entered into the model in which baseline months were coded as "0" and the intervention months were coded 1 - 4 in chronological order. With both Time and Time_Int included in the analysis, a significant effect of Time_Int would indicate that the slope of energy use during the intervention phase shifted significantly from the average linear pattern observed across all months (Singer & Willett, 2003). A non-significant effect of Time_Int in Model B indicated that this was not the case. In model C the variable Group was entered into the model, the Group x Time_Int interaction effect was added in Model D.

Table 4
Summary of Model Results Predicting Shifts in the Trajectory of Change in kWh Consumption

	Model A			Model B			Model C			Model C		
	β	*F*	*p*	*β*	*F*	*p*	*β*	*F*	*p*	*β*	*F*	*p*
kWh 2006	0.36	21.56	< 0.01	0.36	21.35	< 0.01	0.37	21.76	< 0.01	0.34	18.09	< 0.01
kWh 2007	0.61	60.17	< 0.01	0.62	60.63	< 0.01	0.61	58.41	< 0.01	0.64	65.37	< 0.01
Time	-0.04	12.55	< 0.01	-0.05	3.69	0.06	-0.05	3.64	0.06	-0.05	3.75	0.06
Time_int				0.02	0.32	0.57	0.02	0.30	0.58	-0.05	0.32	0.57
Group							-	0.49	0.69	-	0.44	0.72
Group x Time_int										-	5.37	< 0.01

Note. The standardized parameter estimates (*β*) are presented for continuous variables only.

A significant interaction effect in Model D indicated that shifts in the trajectory of energy use differed across experimental groups. The adjusted means for each time-point, mean-centered around baseline within groups, are plotted in Figure 4. A simple visual inspection of this graph suggests that kWh consumption in the control and peer education groups remained relatively stable over time, if not increased slightly during the intervention months. On the other hand, energy use in the feedback and combined groups appeared to decline during the intervention months, relative to baseline. This pattern seemed to be more pronounced in the combined group, which declined more steadily over time, than in the feedback group, which experienced the largest drop in energy use during the initial two months of the intervention period and gravitated back towards the mean during the latter two months. The general pattern described here is mirrored in the analysis of mean changes over time, presented above, which showed slight but non-significant increases in kWh consumption in the control and peer education groups and significant decreases in the feedback and combined groups.

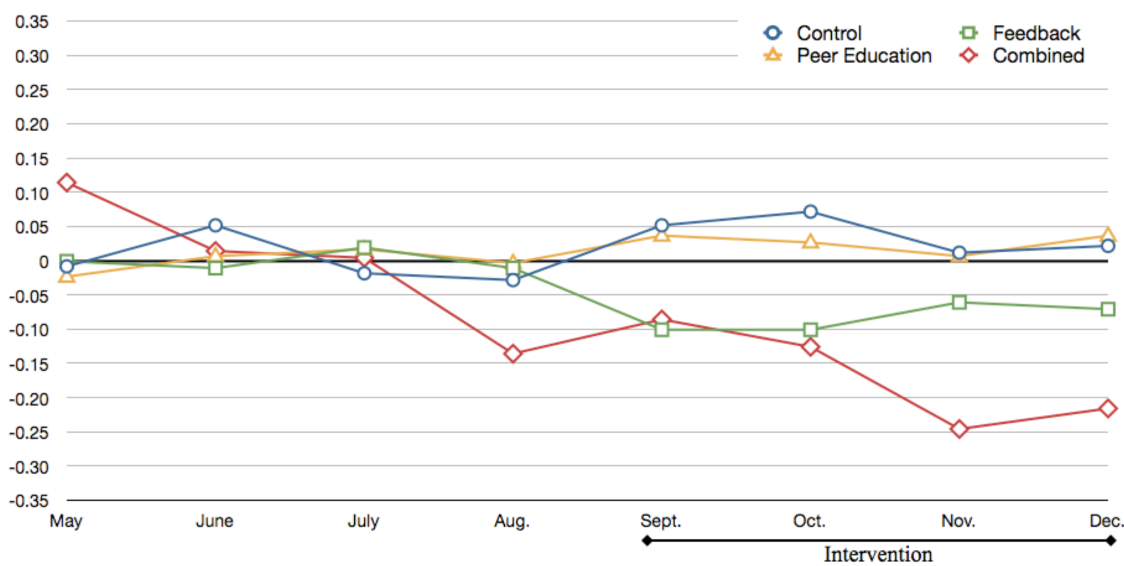

Figure 4. Trajectory of kWh consumption over time as a function of intervention group. Values are adjusted means controlling for historical consumption and are centered around the baseline average within treatment group.

To further investigate the source of this interaction, the magnitude of the shift in slope for each of the intervention groups were separately compared to the control group. Regression lines have been plotted in Figure 5 to describe the linear trend over the intervention months as compared to the baseline trajectory, which represents the pattern of change that would be expected if no shift in the trajectory had occurred. This has been done separately for each treatment condition.

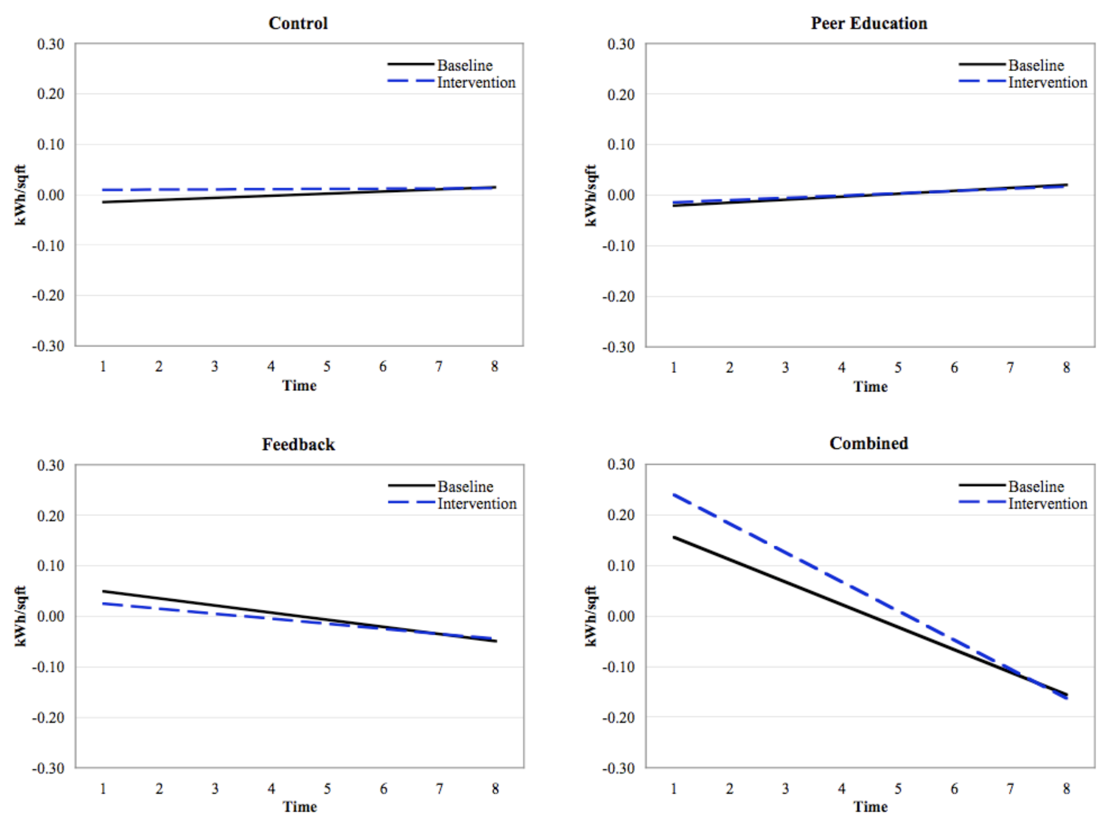

Figure 5. Linear trend over time during the intervention phase as compared to baseline trajectory, within-groups. The solid line representing the baseline trajectory indicates the pattern of change expected if the intervention was not associated with a shift in the trajectory of change.

Comparisons to the control indicated a marginally significant difference between the control group and the feedback group, F (1, 72) = 3.81, $p = 0.06$. As can be seen in the top left-hand corner of Figure 5, kWh consumption in the control group increased slightly over time and there was some evidence that the rate of increase tended to slow during the intervention. In the feedback group, the overall pattern was a downward trend in energy use; however, kWh appeared to decline at a slower rate during the intervention. This linear trend may be explained by an extinction effect in which kWh consumption dropped most steeply during the first two months of the intervention and began to regress back towards the mean during the latter two months; however, more time points would be needed to determine if this is the case.

A significant difference was also found between the control and combined groups, F (1, 69) = 10.16, $p < .01$. In the combined group, the overall pattern was a downward trend in kWh consumption; however, energy use declined more steeply during the intervention months as can be seen in the lower right-hand portion of Figure 5.

No difference was found between the control and peer education groups, F (1, 65) = 0.53, $p = 0.47$. Based on the slopes plotted in the top right-hand corner of Figure 5, it appears that the trajectory of change during the intervention was essentially equivalent to the baseline trajectory within this group. Similarly, the combined and feedback groups were compared to determine if the combined group was associated with a larger reduction in kWh over time and no difference was found, F (1, 76) = 2.45) = 2.45, $p = 0.12$.

Treatment received analysis. The analyses presented above were replicated based on the treatment received by each building. Because the feedback and combined conditions were unaffected by re-assignment into groups based on the treatment received, only results involving the control and peer education groups are discussed.[6] The first set of analyses examining mean changes across the baseline and intervention phases indicated that the pattern of results changed only slightly from the previous analysis. Here, energy use actually increased significantly in the control group, t (145) = 1.96, p = 0.05, g = 0.21, from 1.56 at baseline to 1.63 during the intervention. Within the peer education group, kWh consumption remained stable from baseline to during the intervention, t (145) = -0.39, p - 0.69, g = -0.08. Although this effect was not significant, relative to the pattern of means observed in the intent to treat analyses, where kWh increased slightly from 1.58 to 1.61, the means observed here indicated a slight decrease, from 1.65 at baseline to 1.63 during the intervention.

The next set of analyses examined shifts in the trajectory of change over time. Again, this analysis replicated the Group X Time_int interaction effect described above, F (3, 144) = 7.03, $p < .01$. The top portion of Figure 6 shows the adjusted means for the control and peer education groups only. When compared to the means plotted in Figure 4 based on the intent to treat analyses, Figure 6 suggests that the control group was essentially unaffected by the inclusion of the two additional buildings that were assigned to receive the peer education treatment, but did not. On the other hand, Figure 6 suggests that the buildings that did ultimately receive the peer education intervention showed a decline in energy use beginning one month after the intervention had begun and persisting throughout the duration of the intervention. This shift in the trajectory of

[6] Paired contrasts in which the feedback and combined groups were compared to the control were re-examined in the treatment received analyses and the results were identical to those reported in the intent to treat analyses.

change within the peer education group was significantly different from the control group, F (1, 65) = 6.43, $p < .05$. Fitted regression lines for both groups are presented in the bottom portion of Figure 6. The shift in slope within the peer education group was also compared to the combined group to determine if the combined intervention was more or less effective. The results indicated that there was no difference between the two interventions, F (1, 55) = 0.05, p = 0.82.

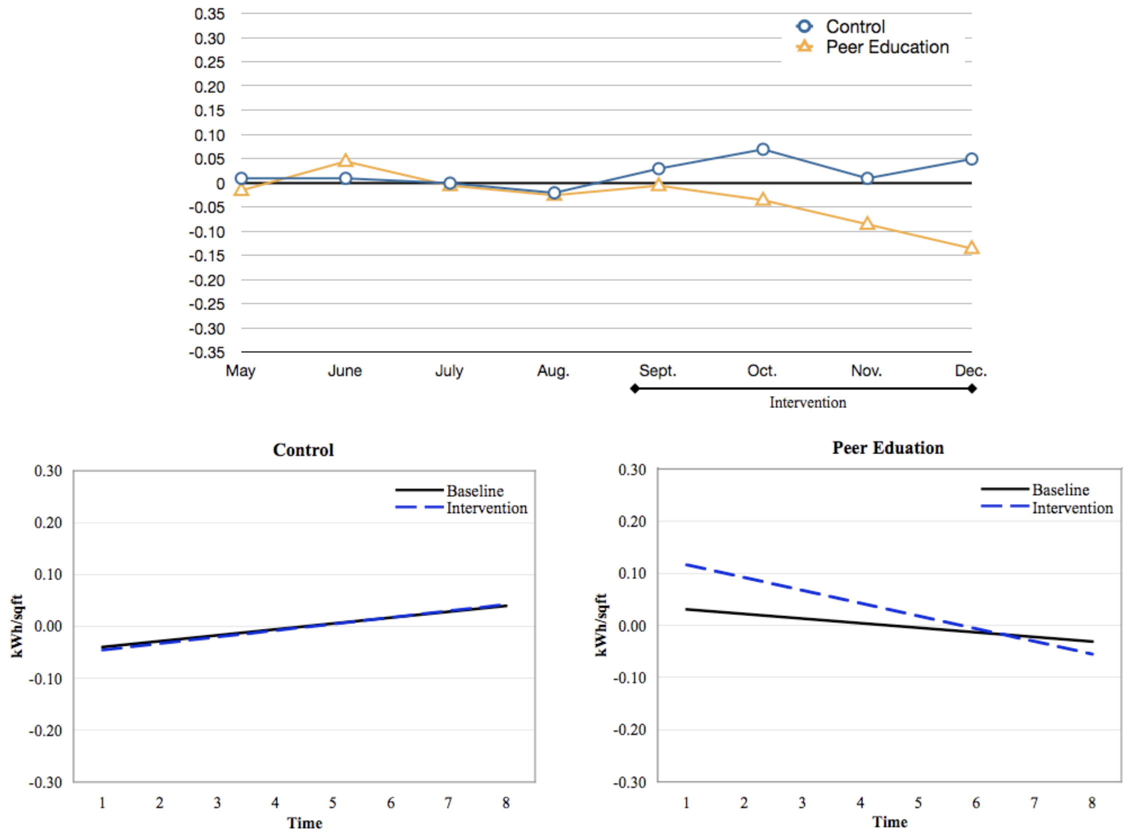

Figure 6. Trajectory of change and shifts in the trajectory of change, relative to baseline, as a function of those who ultimately received the control and peer education interventions.

An additional set of analyses were run to examine the effects of the peer educator's level of involvement on kWh consumption. Only buildings that received the peer education intervention were included. In the first analysis, a two-level random intercept model was used to predict kWh consumption during the intervention. Historical kWh consumption in 2006 and 2007, as well as baseline consumption, were included as covariates. Because there were differences between the peer education and combined groups in the number of e-mails sent and whether the peer educator organized additional efforts in his/her building[7], a dummy coded variable for treatment group was also entered as a covariate. The main effects of Time and the number of e-mails sent by the peer educator were entered as fixed effects in addition to the Time X E-mails interaction term. Results indicated a significant Time X E-mails interaction effect, $F(1, 24) = 5.64$, $p < 0.05$. The plot of this effect is presented in the left side of Figure 7. This model was repeated with the variable Extra included in place of Emails and, again, there was a marginally significant interaction effect, $F(1, 24) = 3.99$, $p = 0.06$, which is plotted on the right-hand side of Figure 7. In both cases, the pattern of results suggests that kWh consumption declined over the course of the intervention within building in which the peer educator was highly involved; yet, remained stable in building where the peer educator was less involved.

[7] More e-mails were sent by educators in the peer education intervention group ($M = 3.08$) than in the combined group ($M = 2.33$). However, more educators in the combined group organized additional efforts in their buildings ($n = 3$) than in the peer education group ($n = 1$).

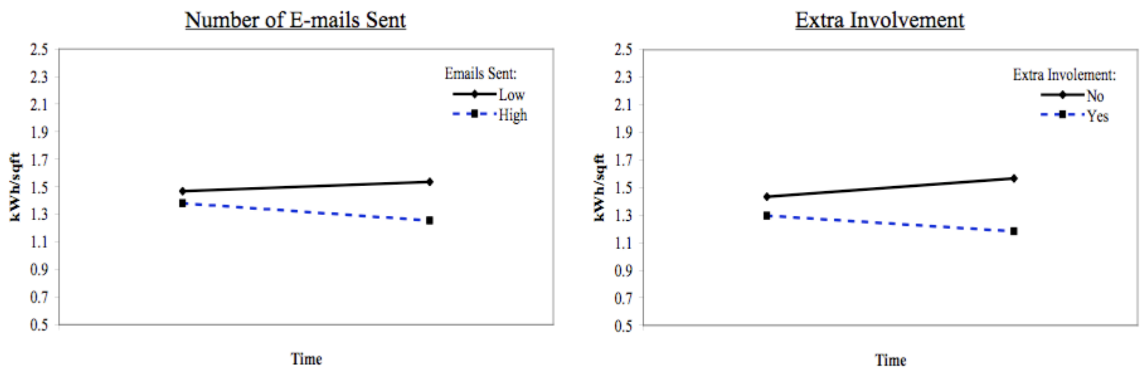

Figure 7. Plot of the Time X E-mails and Time X Extra interaction effects demonstrating the influence of peer educator involvement on kWh consumption during the intervention.

Behavioral Observation Data

A total of seven energy audits were conducted throughout the study. This includes two baseline audits and five audits conducted during alternating weeks throughout the intervention. Three outcome variables were calculated for each building and will be included in the analyses below, these include the proportion of lights turned off in unoccupied rooms (Lights - unoccupied), the proportion of lights turned off in occupied rooms (Lights-occupied), and the proportion of office equipment turned off unoccupied rooms (Equipment).

Outlier analysis. Similar to the kWh data, there was a large degree of between-building variance in the proportion of lights and equipment turned off during behavioral observation. For example, the average proportion of lights turned off in unoccupied rooms for each building ranged from 20% to 76%. To screen for outliers, descriptive statistics and boxplots for each outcome variable were examined within-buildings. Including all three outcome variables, 18 data points were identified as potential outliers out of a combined total of 448 observations across the three variables. These outliers were flagged and the analyses presented below were run with and without them included. This had no substantive effect on the results and, therefore, the outliers are included in all analyses presented below

Preliminary analyses. Prior to analysis, these variables were examined for group differences at baseline on each of the three outcome variables and none were found. Descriptive statistics for the dependent variables during the baseline and intervention phases are presented in Table 5. The data indicate that, in the average building, lights were turned off in unoccupied rooms 52 to 62% of the time. The increase from baseline to the intervention phase may be associated with the start of the semester, which began between the first and second audits during the baseline period of data collection. Slight changes were also observed in the proportion of lights turned off in occupied rooms, which decreased from 21% at baseline to 14% during the intervention. The proportion of unused equipment turned off did increase from 21% to 26%.

Table 5
Means and Standard Deviations of Observed Conservation Behavior at Baseline and Follow-up.

	Baseline			Follow-up		
	n	*M*	*SD*	*n*	*M*	*SD*
Lights - unoccupied	48	0.62	0.24	117	0.52	0.24
Lights - occupied	48	0.21	0.20	116	0.14	0.13
Equipment	33	0.21	0.18	86	0.26	0.20

Note. Two audits were conducted during baseline phase allowing for 48 potential observations. Five audits were conducted during the intervention, allowing for 120 potential observations.

A visual examination of the distributions indicated that the proportion of lights turned off in occupied rooms and the proportion of unused equipment turned off were both significantly skewed in the positive direction. Although both distributions were non-normal, Maas & Hox (2004) have shown that multi-level models are robust to violations of normality, particularly when interpreting fixed effects parameters as will be done here. Correlations among the three dependent variables were examined and none were found, indicating that the three behaviors were largely independent from one another. Because the models presented below will be run separately for each of the three outcome variables, inflation of type I error is a concern. Family-wise error rate was controlled for using a Bonferroni correction in which the threshold for statistical significance was set at *alpha* = 0.02.

A series of initial models were estimated to determine the degree of between- and within-building variance and to examine the effects of the covariates. The intraclass correlations for each measure indicated that between 21 to 50% of the variance in these measures fell between buildings and, therefore, the majority of variance was accounted for by fluctuations over time within buildings. Despite the large degree of within-building variation, the random effect of time in this model was not significant, suggesting that the slope of change over time did not vary across buildings. This, again, suggests a random-intercept model is the preferable means of estimating between- and within-building variation in these data.

Four variables were examined as potential covariates, including: the day of the week the audit was conducted (Day), the time of day (Hour), the RA conducting the audit

(RA), and whether or not courses were in session at the time of the audit (Courses). Only Courses was a significant predictor for two of the three outcome variables. When courses were in session fewer lights were turned off in unoccupied rooms, F (1, 139) = 6.87, $p < .01$, as well as occupied rooms, F (1, 140) = 12.38, $p < .01$. Courses had no effect on the proportion of equipment turned off. This variable was controlled for in all subsequent analyses.

Intent to treat analyses. To examine mean changes in observed conservation behavior from baseline to the intervention phase, a two-level random intercept model was used to predict each of the three outcome variables. The covariate Courses was entered first, followed by the main effects of Phase and Group, and the Phase x Group interaction effect. Both the main effects and the interaction term were non-significant for all outcome variables. Thus, there appeared to be no mean change in conservation behavior from baseline to the intervention phase, as well as no group differences in levels of change over time.

Next, the trajectory of change in observed conservation behavior was examined. In this analysis, the variable Time was entered as a predictor, along with the variable Time_int, to examine the presence of shifts in the trajectory of change during the intervention phase. Also included in the model was the group variable for intended treatment condition and the Group x Time_int interaction effect. Again, all results were non-significant.

Treatment received analyses. These analyses were replicated based on the treatment received by each building. There were no changes in the pattern of results presented above. The level of involvement of the peer educator was also examined using a series of two-level random intercept models to predict observed conservation behavior during the intervention. Courses was entered as a covariate, as well as baseline behavior and a dummy-coded variable for intervention group. In the first model, the main effects of Time and E-mails were examined as well as the Time X E-mails interaction effect. All results were non-significant. This model was repeated with extra involvement included as the predictor variable and, again, the results were non-significant.

Survey Data

Four variables were examined to assess changes in self-reported conservation behavior. These include the proportion of time individuals reported turning off unused computer equipment (Computer), lights (Lights), and office equipment (Equipment), as well as the proportion of time respondents reported adjusting their thermostat before leaving work for the day (Thermostat). During each survey, respondents reported on their behavior during the previous 5-day work week.

Outlier analysis. Prior to analysis, the four outcome variables were screened for outliers. Boxplots indicated there were no outliers on the Equipment and Thermostat variables. Four observations were identified as extreme on the variable for Computer use, and nine cases were identified on the Lights variable. These observations were flagged and the analyses presented below were run with and without the outliers included. Because the exclusion of outliers had no effect on the results, they are included in all analyses presented below.

Analysis of Missing Data. When data are incomplete there is a potential for biased estimates due to systematic differences among the individuals who provided complete and incomplete data. In the present study, this is most relevant to the issue of whether individuals who completed the follow-up survey (n = 352) differed from those who did not (n = 243) on one more more of the study variables. To examine this question, a dummy-coded variable (Missing) was created in which those who completed both waves of the survey were assigned a value of "1", and those who did not were assigned "0." Using a series of hierarchical linear models, this variable was used to predict baseline levels on the four behavioral outcome variables, as well as the eleven psychological variables.[8] The results indicated that there were no differences in self-reported conservation behavior between those who did and did not complete the follow-up survey. Likewise, no differences were found on the measures of outcome expectancy, conservation goal, organizational identity, descriptive norms, or injunctive norms. As such, these data suggest that those who completed the follow-up survey are equally as representative on the domains examined in this survey as those who completed the baseline survey.

Preliminary analyses. Descriptive statistics for the four measures of self-reported conservation behavior at baseline and follow-up are presented in Table 6. Baseline scores were compared between the four treatment groups to test for the presence of group differences and none were found. A visual examination of the distributions associated with these variables indicated that Computers and Lights were significantly skewed in the

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[8] These variable will be examined in more detail in a subsequent section.

negative direction. In particular, the mean of lights was very high both at baseline (*M* = 0.82) and follow-up (*M* = 0.85). The distributions for the remaining two variables were bimodal, with large proportions of the population reporting that they either did not engage in these behaviors at all, or engaged in them nearly 100% of the time. As discussed earlier, the analyses presented below are robust to violations of normality; however, because large proportions of the sample were 100% compliant at baseline, particularly in the cases of Lights (55%) and Equipment (41%) there is a possibility of ceiling effects which can lead to distorted results when examining change over time.

Table 6
Means and standard deviations of self-reported conservation behavior at baseline and follow-up.

		Baseline		Follow-up		
	n	*M*	*SD*	M	SD	*t*
Computer	278	0.56	0.27	0.63	0.27	3.48**
Lights	270	0.82	0.22	0.85	0.22	1.78^
Thermostat	91	0.25	0.44	0.26	0.43	0.11
Office Equipment	104	0.51	0.41	0.60	0.40	1.75^

^$p < .10$, *$p < .05$, **$p < .01$
Note. Value for *n* represents the number of participants who responded to this item at both waves of measurement.

Despite a high degree of compliance at baseline, there was some evidence of behavior change across waves. A series of hierarchical linear models were run to estimate change in the outcome variables from baseline to follow-up. The proportion of time respondents reported turning off computer equipment increased significantly from 56% at baseline to 63% at follow-up. There were also marginally significant increases in the proportion of time respondents reported turning off lights and office equipment. The presence of group differences in the degree of change will be examined below, which may qualify these effects; however, these data suggest there was some effect of the campaign on conservation behavior.

Correlations among the four dependent variables were also examined. Turning off computer equipment, lights and office equipment were all inter-correlated within the range of $r = 0.15$ to 0.24; whereas adjusting thermostats was unrelated to these three variables. Because the models presented below will be conducted separately for each of the four dependent variables, family-wise error rate was controlled for using a Bonferroni correction, with the threshold for statistical significant set at *alpha* = 0.01.

A series of initial null models were examined to assess the degree of between- and within-building variance. The intraclass correlation coefficients for turning off lights and computer equipment were very small ($\rho = 0.05$ and 0.03, respectively), suggesting there was little variation between buildings and, in both cases, the degree of between-building variance was non-significant. The building classification accounted for substantially more variance in adjusting thermostats ($\rho = 0.19$) and turning off office equipment ($\rho = 0.13$). This is not surprising considering that differences do exist between buildings with respect to access thermostats and office equipment; while there is little reason to expect the use of lights and computer equipment to differ across buildings.

Intent to treat analyses. A series of two-level hierarchical linear models were run to examine group differences in self-reported conservation behavior. In each model the baseline level of the dependent variable was entered as a covariate and the four-level variable for intended treatment group was entered as a fixed effect. The results indicated there were no differences between groups on any of the four dependent variables.

Treatment received analyses. The analyses reported above were replicated based on the treatment received grouping, and the results were identical. It is important to point out that only 25 of the 352 respondents who completed both surveys were located in one of the two buildings affected by this re-assignment into groups. Therefore, it is unlikely that changes would be observed in these analyses even if differences did exist in "reality," as was indicated in the kWh data.

To assess whether the level of involvement of the peer educators had an effect on the degree of behavior change reported, the variables E-mails and Extra were examined as moderating factors within the subset of participants ($n = 174$) who received the peer education treatment. After controlling for baseline and whether participants received the feedback intervention, each measure of conservation behavior was separately regressed onto the two predictor variables. Results indicated that there was no effect of the number of E-mails on behavior change. There was a significant effects of Extra on the proportion of time respondents reported turning off lights, F (1, 116) = 6.74, $p < 0.01$, $g = 0.31$. Survey respondents turned off lights more often in buildings where the peer educator organized additional efforts ($M = 0.94$, $SE = 0.02$) in comparison to those where the educator did not ($M = 0.84$, $SE = 0.03$).

Psychological Mechanisms Associated with Energy Conservation

The final series of analyses examined the mechanisms by which the feedback and peer education interventions influenced behavior. Descriptive statistics for the set of variables considered in these analyses, as well as an examination of mean changes over time, are presented in Table 7. A visual inspection of the distributions indicated that two measures, outcome expectancy and conservation goal, were highly skewed in the negative direction. Baseline scores near the extreme high ends of the distributions, particularly on the measure of conservation goal, suggests that the majority of the sample was already highly concerned about energy use and the environment prior to the start of the intervention. Not surprisingly, given these baseline values, there was no change in mean ratings from baseline to follow-up. The measures of descriptive and injunctive norms, as well as organizational identity, were more normally distributed and some changes were observed from baseline to follow-up. Participants seemed to perceive that more people in their department turned off lights and office equipment at follow-up relative to baseline. Likewise, there was an increased perception that engaging in these behaviors would be met with approval by one's peers.

Table 7
Descriptive statistics and mean changes over time for eleven psychological variables.

		Baseline		Follow-up		Mean
	n	*M*	*SD*	*M*	*SD*	Change
Outcome Expectancy	331	4.05	0.69	4.03	0.68	t = 0.37
Conservation Goal	334	4.40	0.62	4.36	0.68	t = -1.15
Organizational Identity	329	3.61	0.89	3.69	0.90	t = 1.19
Descriptive Norm (Computer	254	3.01	1.48	3.13	1.30	t = 1.57
Injunctive Norm (Computer)	266	3.18	0.53	3.24	0.61	t = 1.61^
Descriptive Norm (Lights)	261	4.09	1.24	4.37	1.04	t = 3.44**
Injunctive Norm (Lights)	264	3.57	0.73	3.72	0.68	t = 2.89**
Descriptive Norm (Thermostat)	93	1.74	1.15	1.85	1.12	t = 0.04
Injunctive Norm (Thermostat)	95	3.17	0.4	3.14	0.42	t = -1.08
Descriptive Norm (Office Equip.)	139	2.62	1.47	2.98	1.45	t = 3.62**
Injunctive Norm (Office Equip)	144	3.24	0.49	3.34	0.56	t = 1.77^

Note. Response options for all measures were made on a 5-point scale.
^$p < .10$, *$p < .05$, **$p < .01$

Feedback - Mediator and Moderator Analyses

In Hypothesis 3 it was predicted that the effect of the feedback intervention on self-reported conservation behavior would be mediated by outcome expectancy beliefs, and outcome expectancy would, in turn, be moderated by the presence of a goal to conserve energy (Hypothesis 4). As with traditional OLS regression, mediation in multi-level modeling can be tested by estimating a series of three multi-level regression equations to establish that: (1) the initial predictor variable (in this case, feedback) is correlated with the outcome (conservation behavior), (2) the initial variable is correlated with the mediator (outcome expectancy), and (3) when both the initial variable and the mediator are included in the model, the mediator remains significant whereas the effect of the initial variable is reduced (partial mediation) or drops out entirely (full mediation; Baron & Kenny, 1986; Krull & Mackinnon, 1999). The series of results presented above suggest that criterion 1 has not been met because the feedback intervention was not related to self-reported conservation behavior. However, to re-examine this question after isolating the effects of feedback, a dummy-coded variable for the presence of the feedback intervention was created in which the control and peer education groups were assigned values of “0”, and the feedback and combined groups were assigned values of “1”. This variable was entered into a hierarchical linear model to predict each of the four behavioral measures after controlling for baseline values. The results were not significant and, therefore, Hypothesis 3 was not supported.

Despite the fact that mediation was not supported, a series of subsequent analyses were conducted to examine the relation between feedback and outcome expectancy, as well as the effect of outcome expectancy on conservation behavior. In the first analysis, outcome expectancy measured at time 2 was regressed onto the feedback variable after controlling for baseline levels. All results were non-significant suggesting that feedback had no effect on expectancy beliefs.

The next set of analyses examined whether outcome expectancy beliefs were related to conservation behavior. First, each of the four behavioral measures were regressed onto the measure of outcome expectancy collected during the same wave. This was done for both the baseline and follow-up data. Results indicated that outcome expectancy was not related to conservation behavior at baseline. However, there was some indication of a significant linear relation at follow-up. Higher levels of outcome expectancy were marginally related to the frequency with which respondents reported turning off unused lights, $\beta = 0.12$, $p = .04$, $R^2 = 0.01$. There was also some indication that it was related to turning off computer equipment, $\beta = 0.10$, $p = 0.08$, $R^2 = 0.01$; however, this effect did not reach the level of marginal significance after correcting for type-II error.[9]

Although mean levels of outcome expectancy did not change from baseline to follow-up, the two correlations found only at follow-up may suggest that those with higher scores on this measure were more responsive to the intervention and were, therefore, more likely to take steps to conserve energy. To examine this question, a series of regression analyses were conducted in which conservation behavior at Time 2 was regressed onto outcome expectancy scores at Time 1. It each analysis, the baseline

[9] Levels of statistical significance are adjusted to control for family-wise error using a Bonferroni correction in which *alpha* = 0.01.

behavior score was included in the model as a covariate. There was some indication that higher outcome expectancy beliefs at baseline was associated with an increase in the proportion of time respondents reported turning off computer equipment, $\beta = 0.10$, $p = 0.06$, $R^2 = 0.02$, as well as lights, $\beta = 0.10$, $p = 0.05$, $R^2 = 0.01$. However, neither of these effects reached the threshold for statistical significance after adjusting for family-wise error (marginal statistical significance was set at $p < .03$). Furthermore, the effect sizes in both cases were very small and, therefore, this variable has little predictive value in the present context.

In addition to the role of outcome expectancy as a mediator, it was also predicted in Hypothesis 4 that the endorsement of a goal to conserve energy would moderate the effect of outcome expectancy on conservation behavior. To examine this, the analyses described above were replicated after adding the main effect for conservation goal, as well as the goal X outcome expectancy interaction term. There was some evidence of a direct effect of conservation goal within waves. A higher value on this measure was positively related to the proportion of time respondents reported turning off unused lights $\beta = 0.19$, $p < .01$, $R^2 = 0.03$. However, this was found only at follow-up and there were no other significant effects for the remaining variables. There was also no evidence that conservation goal was related to increases in conservation behavior over time. Furthermore, non-significant interaction terms suggested this variable did not moderate the effect of outcome expectancy on behavior. Thus, Hypothesis 4 is not supported.

Peer Education - Mediator and Moderator Analyses

In Hypotheses 5 and 6 it was predicted that the effect of peer education on conservation behavior would be mediated by the perception of both descriptive and injunctive norms. To isolate the effects of peer education, the four measures of conservation behavior at follow-up were each regressed onto a dummy-coded variable in which the peer education and combined groups were coded as “1” and the feedback and control groups were coded as “0”. As in previous analyses, baseline behavior scores were controlled for in this model. The results were non-significant and, as a result, there is no support for Hypotheses 5 and 6.

In a subsequent analysis, the influence of peer education on descriptive and injunctive norms was examined. A two-level hierarchical linear model was used to compare mean scores on each of the descriptive and injunctive norm variables at follow-up after controlling for baseline. All results were non-significant and, therefore, it appears that the peer education intervention had no effect on normative perceptions.

Next, the relation between the perception of social norms and conservation behavior were examined. Table 8 presents the within-wave regression coefficients between these two sets of measures. Each measure of behavior was regressed separately onto descriptive and injunctive norms and, in each analysis, only the norm measure specific to that behavior was used. The results indicate that descriptive norms were related to the proportion of time respondents turned off unused lights at baseline. Likewise, both descriptive and injunctive norms were related to adjusting one’s thermostat and turning off unused equipment at both baseline and follow-up. Of particular interest is the size of the relations between descriptive norms and the acts of turning off thermostats and office equipment. The standardized regression coefficients, in both cases, were within the range of 0.40 to 0.80 which are large effects by any standard within the social sciences, but are particularly large considering the outcome variables purport to measure behavior. These findings suggest that the acts of adjusting one's thermostat and turning off unused office equipment are closely related to the perception of whether others are also engaging in these behaviors and, to a lesser extent, whether others approve or disapprove of these actions. In a second series of analyses, descriptive and injunctive norms, which were correlated within the range of $\beta = 0.23$ to $\beta = 0.40$ depending on the behavior, were entered into the model simultaneously. In this case, the two effects of injunctive norms on Thermostat and Office Equipment became non-significant, indicating that this variable did not account for a significant proportion of variance above and beyond descriptive norms.

Table 8
Within-wave regression coefficients between conservation behavior and descriptive and injunctive norms.

	Descriptive Norms						Injunctive Norms					
	Baseline			Follow-up			Baseline			Follow-up		
	β	p	R^2	β	p	R^2	β	p	R^2	β	p	R^2
Computer	0.08	0.23	0.01	0.06	0.33	0.01	0.04	0.51	<.01	0.03	0.56	<.01
Lights	0.14	0.02	0.02	0.08	0.12	0.01	0.07	0.22	0.01	0.02	0.71	<.01
Thermostat	0.59	<.01	0.34	0.36	< 0.01	0.09	0.28	<.01	0.03	0.24	< 0.01	0.04
Office Equipment	0.69	< 0.01	0.43	0.78	< 0.01	0.52	0.32	< 0.01	0.10	0.36	< 0.01	0.08

Next, the extent to which social norms were related to increases in conservation behavior over time were examined. In a series of hierarchical linear models, descriptive and injunctive norms at baseline were entered into the model simultaneously to predict conservation behavior at follow-up after controlling for baseline values.[10] The results indicated that a higher perceived injunctive norm at baseline was associated with an increase in the proportion of time respondents reported turning off lights, $\beta = 0.17$, $p < .01$, $R^2 = 0.03$. There was also a marginally significant effect in which higher levels of descriptive norms at baseline were associated with an increase in the proportion of time respondents reported adjusting thermostats at follow-up, $\beta = 0.25$, $p = 0.05$, $R^2 = 0.05$.

In the final set of analyses, the effect of organizational identity on conservation behavior was examined. In Hypotheses 7 and 8 it was predicted that a strong organizational identity would amplify the effect of descriptive and injunctive norms on behavior. It was also predicted in Hypothesis 9 that organizational identity would exert a direct effect on conservation behavior, based on the desire to promote a positive image of the in-group. Results from both within-wave and across-wave regressions indicated that, contrary to Hypothesis 9, there was no main effect of organizational identity on conservation behavior. Similarly, there was no interaction effect between organizational identity and descriptive norms, nor with injunctive norms. Thus, no support was found for Hypotheses 7 and 8.

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[10] To ensure that results were not affected by multi-collinearity between the two predictors, these models were also run with descriptive and injunctive norms entered into the models individually. The overall pattern of results did not change as a result.

CHAPTER IV

CONCLUSIONS

This dissertation sought to evaluate the effectiveness of two interventions, feedback and peer education, in reducing energy use within an organizational setting. As discussed earlier, energy use within the workplace poses a unique challenge to those wishing to motivate behavior change. In this context, individuals have no direct financial incentive to conserve energy and, in contrast to households, where individuals typically receive a monthly energy bill, employees receive little information about how much energy they use and the impact of their consumption. Like many organizations, the institution in which these interventions were evaluated required an approach that would be effective, inexpensive, and relatively easy to implement on a large scale, as well as a program that could be sustained over an extended period of time. As will be discussed in more detail below, these two interventions appeared to fulfill many of these criteria.

Although there were some inconsistencies across data sets, results from the most valid and objective indicator of energy consumption, the number of kWh's consumed, suggested that both feedback and peer education resulted in a significant decline in energy use relative to baseline. This was in contrast to the control condition, which involved an information-only intervention, where there was some evidence of an increase in energy use during the intervention. This finding is consistent with earlier work in this area which suggests that information alone has some capacity for influencing attitudes and beliefs but, ultimately, has little impact on actual behavior (e.g., Abrahamse, et al., 2005; Costanzo, et al., 1986; Henry and Gordon, 2003; Tertoolen, et al., 1998). When summed across all buildings that received peer education or feedback (or both), a total of 470,000 kWh of energy was saved. This translates into roughly $25,000 in reduced cost expenditures for the organization and the prevention of over 680,000 pounds of CO_2 from entering the atmosphere. To put these figures in context, eliminating 470,000 kWh of electricity (and the accompanying CO_2 emissions) would be roughly equivalent to removing 500 homes in the United States from the electricity grid in any given month.[11] The fact that these effects were produced in a context in which there was no economic reward for individuals to modify their behavior contradicts traditional economic analyses of this issue, which assumes meaningful changes in behavior cannot be achieved without strong financial incentives (for review, see Ehrhardt-Martinez, 2008; Wilson & Dowlatabadi, 2007). It also provides additional evidence that efforts to address consumer demand need to look beyond the traditional attitude-persuasion approach, which relies almost exclusively on information to motivate behavior change, in favor of strategies that may be both more powerful and cost-effective.

In the sections below, the results associated with each of the two interventions will be discussed in more detail, including an examination of their utility from an implementation standpoint. The theoretical and applied significance of these findings will also be considered and recommendations will be made for future research efforts. Finally,

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[11] Based on the average monthly energy consumption of households in the United States (Energy Information Administration, 2007).

the implications of this study will be discussed in light of current efforts to curb energy demand and reduce greenhouse gas emissions nationwide.

Summary of Results from the Feedback Intervention

Hypothesis 1 predicted that buildings receiving the feedback intervention would show a steeper decline in energy use during the intervention than those that were assigned to the control group. Although there was no support for this hypothesis from the behavioral observation and survey data, results from the kWh data suggested this to be true. Buildings that received feedback documenting their energy use during the previous month showed a significant drop in kWh that appeared directly after the feedback was first administered and remained below baseline for the duration of the intervention. These buildings, on average, used 5% less energy per month relative to before the intervention began. Although less than the 15% reduction that was the stated goal of this energy conservation campaign, within the context of the current sample this amounts to a substantial reduction in cost and CO_2 emissions. Effects of the feedback intervention alone (not including the combined intervention group) led to a reduction of over 140,000 kWh of electricity and nearly 204,000 pounds of CO_2.

The mean decline in energy use shown here is consistent with other findings in the literature, which have generally been within the range of 0 to 20% (e.g., Benders et al., 2006; EPRI, 2009; McClelland & Cook, 1980; Sexton et al., 1987). These studies have included a wide variety of feedback instruments, ranging from simple graphs presented on monthly energy bills to sophisticated product-integrated feedback displays that provide real-time information. Although a 5% change in energy use is at the low end of this range of effect sizes, it is still impressive considering the nature of the feedback that was administered. The majority of work in this area has been examined within the context of household energy use, in which feedback closely reflects the behavior of one or a handful of individuals living within the home. Feedback within the current study reflected the behavior of dozens or, in some cases, hundreds of individuals who shared an office building, in addition to the many students and visitors who also utilized that space. Likewise, the data presented in the feedback graphs were aggregated across the month and, therefore, were not a source of immediate behavioral reinforcement as is more continuous feedback. Although a number of studies have shown infrequent feedback to be effective (e.g., Hayes & Cone, 1977; Van Houwelingen & Van Raaij, 1989), fewer have examined the use of group-level feedback (e.g., Petersen et al., 2007; Rothstein, 1980) and only a handful have used feedback that lacks specificity in both domains (i.e., unit of analysis and frequency; Siero Bakker, Dekker, & van den Burg, 1996). The lack of studies that have demonstrated the effectiveness of low-resolution feedback, paired with the assumptions from the behavioral reinforcement literature, which states that feedback must be specific and immediate (Kluger & DeNisi, 1996), has led some to conclude that low-resolution feedback has no effect beyond raising awareness about energy conservation (e.g., Darby, 2000; Maibach, Roser-Renouf, Leiserowitz, 2008). These data suggest this is not the case.

In the present study, low-resolution feedback was examined for two reasons. First, as discussed above, relatively little has been done to assess its effectiveness, particularly at the group level. Second, and perhaps more important, it was simply more practical to put into effect within a workplace setting and, therefore, more feasible from an implementation standpoint. Like many organizations, the institution examined in this study required an intervention that would be easy to implement on a large-scale and one that could reach a general audience in an environment where employees and students frequently move about throughout the organization. The kWh data used to create this feedback presentation was readily available via monthly energy bills and this intervention simply involved presenting that information in a meaningful way to the members of the organization. Although there is reason to believe that more specific and continuous feedback would be more effective in this context (e.g., for review, see Abrahamse et al., 2005; EPRI, 2009), it would not have been possible without a significant amount of time and investment in personnel and technology. This is not to suggest that organizations should not invest in more sophisticated ways to promote efficiency and conservation in the workplace, particularly as feedback technology becomes more prevalent and cost-effective. However, these data suggest that significant and substantial reductions in energy use can be achieved almost immediately with currently available information and little to no upfront cost.

What is less clear is how long the effects of a feedback intervention such as this can be expected to persist. Despite the significant drop in mean kWh consumption that occurred during the intervention months, there was some evidence of a possible extinction effect in which energy consumption appeared to gravitate back towards the mean during the latter two months of the intervention. This pattern was observed only in the feedback group, whereas kWh use among those who received either the peer education or combined interventions declined much more sharply and was maintained at a level that was well below baseline throughout. With only four time points, it is difficult to determine whether this pattern does, in fact, represent a diminished effect of the intervention over time, or if it can be attributed to random variation. A more prolonged study would be necessary to address this question. The work that has been done in this area has produced somewhat inconsistent findings. Although there is some evidence that feedback effects do diminish over time (e.g., Hutton, Mauser, Filiatraut, & Ahtola, 1986; Sexton, Brown-Johnson, & Konakayama, 1987), the majority of evidence suggests otherwise. For example, McClelland and Cook (1979) evaluated continuous in-home feedback over the course of 11 months and found that there was no evidence that the overall effectiveness of the intervention increased or decreased over time. Additional unpublished reports produced by utility companies have indicated similar findings in which feedback effects were shown to persist for periods as long as 18 months (Mountain, 2006; 2007). However, it should be noted that, although these reports are publicly available, they were not peer reviewed and households that received feedback were not compared to a control condition.

In all of the cases cited above, feedback was presented continuously to individual households. To date, there is only one known study that has evaluated intermittent feedback over an extended period of time. In this research, feedback was presented monthly to households in the form of an enhanced energy bill, which presented a graphical display of energy use during the previous months, and the results indicated savings within the range of 7 to 10% that persisted over the course of three years (Nielsen, 1993). Despite some inconsistencies, this body of work as a whole suggests there is great potential for long-term reductions in response to feedback that is administered over an extended period. It is possible that there may be moderating factors to account for some of these inconsistencies, such as the cost of energy or seasonal variations. Furthermore, additional research should be done to examine whether group-level feedback is also capable of producing long-term changes in behavior.

Despite support for the impact of feedback on behavior, there was no evidence that this effect was mediated by outcome expectancy beliefs, as predicted in Hypothesis 3. The belief that one's personal actions have a meaningful impact on the organization's level of consumption did not change among those who received the feedback intervention, nor did it change from baseline to follow-up in the sample as a whole. This may be at least partially due to a ceiling effect. On average, respondents scored a 4.03 on this measure (on a scale ranging from 1 to 5), and 34% of the sample scored a 4.5 or higher. When these individuals were excluded from the sample, there was some evidence that outcome expectancy increased over time; however, this change did not differ as a function of treatment condition. Although future studies may be able to better test this prediction within a less biased sample and using measures that are more normally distributed, the data presented here suggest that outcome expectancy beliefs may not be responsible for the effect of feedback, at least when presented at the group level.

Consistent with earlier work in this field (Kaiser & Shimoda, 1999; Kerr, 1992), there was some evidence that outcome expectancy was related to behavior. Results from the within-wave regression analyses indicated that those who more strongly believed that their personal actions have an impact on the organization's energy consumption reported that they more often turned off unused lights and computer equipment. Interestingly, these effects were found only at follow-up. There was additional evidence to suggest that higher outcome expectancy beliefs at baseline were associated with increases in these same behaviors over time. The lack of significant findings at baseline, accompanied with this pattern of change, may suggest that the intervention as a whole (regardless of condition) had a greater influence among those who already perceived the impact of their behavior to be significant. In other words, the intervention was ineffective at promoting the perception that one's personal contribution matters to the organization as a whole, but those who did already hold this belief were more likely to adopt steps to reduce their level of energy use when requested to do so. In this sense, outcome expectancy can be thought of as a sort of moderating factor that may affect whether or not individuals will respond positively to attempts to modify their behavior. This is a plausible explanation, and one that would be consistent with expectancy-value theory (e.g., Eccles & Wigfield, 2002). It is, however, qualified by the fact that the magnitude of the relation between outcome expectancy and behavior was very small. These effects were only marginally significant at best and, in some cases, did not reach the threshold for statistical significance after correcting for type-I error. Furthermore, this variable accounted for very little variance in self-reported behavior, with *pseudo* R^2 values ranging from 0.01 to 0.02. Together these results suggest there may be some theoretical significance of this construct and there is reason to examine it in future studies, particularly under improved measurement conditions. However, the utility of this construct for efforts to promote behavior change is still in question.

Contrary to what was predicted in Hypothesis 4, outcome expectancy beliefs were not moderated by the endorsement of a goal to conserve energy. Surprisingly, there was little relation between goals and conservation behavior either within or between waves. The fact that outcome expectancy was, to some degree, related to behavior but not moderated by a conservation goal contradicts some earlier work in this area (Becker, 1978; McCalley & Midden, 2002). However, multiple studies have shown the effect of expectancy beliefs on behavior even when goals to conserve energy were not considered. Again, it is possible, and likely, that this variable was not a factor in the present study simply because the vasty majority of participants endorsed this goal. Less than 9% of the sample scored below the midpoint on this scale, and more than 84% of respondents averaged a four or higher on the three items that comprised this measure. Although this may be a function of the sample, which appears to be highly motivated and interested in this issue, opinion polls suggest this is also fairly typical nationwide. There are known ideological differences in how individuals perceive issues such as climate change (Dunlap & McCright, 2008); however, the majority of Americans will report that they are concerned about the environment and believe that energy conservation is important.[12] As such, goals regarding environmental conservation may be becoming increasingly irrelevant to the prediction of behavior. Instead, researchers may want to focus on

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[12] Based on data provided by the Roper Center for Public Opinion Research, 63% of Americans report they are willing to change their behavior in or to conserve energy and reduce global warming (Civil Society Institute, 2006) and 91% of Americans report that they would support policies that would encourage energy conservation (ABC News/Washington Post, 2001).

variables that do more to determine which individuals are likely to act consistently with the attitudes and goals that they endorse.

Summary of Results from the Peer Education Intervention

The effects associated with peer education were somewhat less clear due to implementation failures in two of the six buildings assigned to receive this intervention. When these buildings were included in the analysis, energy consumption within this group did not differ, on average, from baseline to follow-up, nor did it decline over time. However, when these buildings were re-categorized into the control condition, there was evidence that the treatment was effective, providing support for Hypothesis 2. On average, there was no difference between the baseline and intervention phases; yet, an analysis of the trajectory of change over time indicated that energy use slowly declined over the course of the intervention and that this trajectory represented a significant shift from baseline. A comparison of kWh consumption from the latter two months of the intervention relative to baseline levels revealed a 3% drop in energy use. Compared to the feedback condition, where the effects of the treatment were apparent immediately after the start of the intervention, the influence of peer education evolved much more gradually. In this case, the effect did not become noticeable until the second month of the intervention and did not drop below the range of baseline levels until the third. Not surprisingly, the level of effectiveness was largely contingent upon the quality of the peer education that was received. Evidence from the kWh data indicated that energy use declined most in buildings where the peer educator was highly involved, both with respect to the number of e-mails sent as well as to whether or not the educator organized additional efforts within his or her building. This finding was partially replicated within the survey data, where respondents reported turning off lights more frequently in buildings where the peer educator had organized additional efforts, such as hanging up reminders or distributing energy efficient light bulbs.

This study provides the first known evidence that peer education can be effectively used to motivate energy conservation. Like other work demonstrating the influence of peers on behavior (e.g., Burn, 1991; Hopper & Nielsen, 1991), these findings suggest that when information comes from someone within an individual's social group it tends to be more effective than information that is provided from an outside source or an unknown third party. In this intervention, the peer educators offered little, if any, information that was not already provided in the public education campaign. However, simply receiving this information from someone that the building occupants knew and worked with was enough to motivate behavior change that was not achieved when the information was distributed from a source that the recipients did not personally know. The source of this effect is somewhat unclear. Contrary to what was predicted in Hypotheses 5 and 6, there was no evidence that the effect of peer education was mediated by the perception of descriptive and injunctive norms. There was evidence that both descriptive and injunctive norms for energy conservation increased from baseline to follow-up, particularly with respect to turning off lights and equipment. However, contrary to previous findings (Hopper & Nielsen, 1991), this effect was not isolated to buildings that received peer education, but was observed in all treatment conditions.

An alternative explanation for the effect of this intervention is that peers are simply better able to capture the attention of their colleagues. DiClemente, (1993) has shown that information which comes from a peer is perceived to be more credible than that which comes from a third-party source. Others have shown that individuals will attend more to information when it is delivered by someone they know personally (Buller et al., 2007; Costanzo et al., 1986). There was some evidence for this in the present study. On average, survey respondents reported reading more of the peer education e-mails than the informational postcards, which were delivered by someone outside of the building. This was true regardless of whether respondents received both peer education and postcards, or only the postcards (i.e., the control condition). This could reflect an effect of the medium of communication. For example, it is possible that individuals were more likely to attend to messages delivered via e-mail rather than those that were delivered on paper. In fact, participants were no more likely to read the peer education e-mails than the feedback e-mails. However, previous work has shown information delivered by a peer receives more attention even when the type of information and the medium are held constant (e.g., Buller et al., 2007; Burn, 1991).

Despite evidence of success, the fact that the execution of this intervention failed in 17% of the buildings intended to receive it raises some concerns from an implementation standpoint. This is compounded by the fact that only two out of the 15 peer educators who agreed to participate in the program fully complied with the request to send a total of four e-mails over the course of the campaign. The majority (47%, n = 7) sent three of the four e-mail, which is almost fully compliant; however, six educators

(40%) sent two or fewer. If sending two or fewer e-mails serves as a cut-off point for classifying low-involvement educators, which tended to have little effect on energy consumption, these data suggest that future efforts should expect results in only 60% of the peer networks in which this program is implemented. There may be ways to improve compliance and motivate greater involvement among peer educators, the volunteers in this study were not paid for their time nor offered incentives for participating. Furthermore, there was little done to screen for which educators would have been most likely to fulfill their duties well. Additional work should be done to understand the leadership qualities that are associated with successful peer education efforts. However, in comparison to an intervention such as feedback, which involves substantially less room for error in the implementation process and is more likely to be sustained over longer periods of time, peer education may be the less desirable of the two.

Regardless of the concerns surrounding the implementation of this intervention, these data do suggest that it would behoove organizations to take advantage of personnel who show an interest in organizing efforts to improve efficiency and conservation in the workplace. Speaking anecdotally, this researcher was contacted by a number of individuals throughout the organization who, after receiving the initial materials from the information campaign, were interested in organizing conservation initiatives within their departments. Because this was a randomized and controlled study, we could not facilitate these activities without interfering with the evaluation that was already in place. However, these data suggest that organizations that facilitate these efforts among employees, or at least support them professionally or financially, are likely to see a return on their investment.

Despite the fact that there was no evidence that the influence of peer education was mediated by the perception of social norms, these data also add to the growing body of evidence suggesting that social norms are closely connected to decision-making and behavior (e.g., Borsari, & Carey, 2003; Cialdini et al., 1990; 1991). The within-wave regression analyses suggested that both descriptive and injunctive norms were related to the proportion of time respondents reported adjusting their thermostats and turning off unused office equipment. What is more striking is the magnitude of these relations, particularly in the case of descriptive norms. Roughly 9 to 52% of the variance in behavior was shared with the perception of how often one's peers engaged in these behaviors. This does not necessarily suggest a causal relation, given that these values represent within-wave covariation. It is possible that individuals engaged in these behaviors because their colleagues were doing so. It is also possible that individuals may project their own behavioral patterns on those around them, particularly in cases where others' behaviors cannot be directly observed. There was some evidence for causality based on the between-wave regressions, participants who perceived that their colleagues frequently turned off unused lights also personally engaged in this behavior more frequently from baseline to follow-up. Similarly, those who perceived that their peers disapprove of not adjusting one's thermostat before leaving for the day tended to adjust their own thermostat more frequently at follow-up. This finding is consistent with previous evidence in which a causal link between norms and behavior has been established (both for descriptive and injunctive norms) through experimental designs in which normative information has been manipulated in the environment. However, in the present study, this findings was not consistent across behaviors, the effect sizes were small, and it was not replicated for both descriptive and injunctive norms. Therefore, it remains unclear whether normative perceptions were a motivating factor in the decision to adopt energy conservation practices within the current sample.

Effect of the Combined Intervention

Based on the work of Simon, Stürmer and colleagues, which suggests that there are dual pathways for participation in social movement activities (Simon et al., 1998; Stürmer et al., 2003; Stürmer & Simon, 2004), it was predicted in Hypothesis 10 that buildings receiving a combination of feedback and peer education would show a greater reduction in energy use than those that received only one intervention. Based on the effect sizes and mean changes over time, it appeared that the largest reductions in energy use were achieved within the combined group. Buildings that received the combined intervention achieved a 9% drop in energy use compared to the feedback and peer education groups, which reduced energy consumption by 5% and 3%, respectively.[13] However, paired comparisons indicated that these differences were not statistically significant and, therefore, no support was found for Hypothesis 10.

Stürmer et al. (2003) have shown that individuals who are influenced both by a rational desire to achieve gains as well as the desire to be seen as a "good" group member

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[13] The 3% drop in energy use for the peer education group was for the final two months of the intervention only.

tend to be more willing to participate in social movement activities than individuals who are motivated only by one or the other. In the present study, neither outcome expectancy beliefs nor organizational identity were related to the effectiveness of these interventions. This could explain why the combined intervention was no more effective than either feedback or peer education alone. It is also possible that the failure to show significant differences between these groups, particularly between the feedback and combined groups, could be a result of reduced power. This issue will be discussed in more detail below. However, given the size of the effect within the combined group relative to the other two interventions,[14] additional research should explore whether there may be an added benefit of combining interventions such as these.

Resolving Inconsistencies Across Data Sets

Although the impact of these interventions on energy use, as measured in kWh, provides strong support for their effect on behavior, this pattern of results was not replicated across data sets. Both the behavioral observation and survey data suggested that feedback and peer education were no more effective than the information-only control. This study employed multiple methods with which to measure behavior in order to improve reliability and validity, both of which can be compromised in research that relies on a single measurement technique. While this represents a strength of the study, the use of multiple indicators to assess the same construct also opens the door to inconsistent results, which must be interpreted and, ideally, resolved by the researcher.

[14] *Hedges's g* was -0.52 for the combined group, -0.28 for the feedback group and -0.08 for the peer education group. The effect size for the peer education group is based on the treatment received analysis.

In the present context, there is reason to believe that the kWh data are more reliable and valid than either self-report or behavioral observation. First, these data provided the most extensive picture of energy use given that data were available for the eight months before and during the intervention, as well as from the two years preceding it. This allowed for a more precise estimate of energy use during the intervention relative to the typical level of consumption for each building under "normal" conditions. Second, although kWh data were affected by equipment failures, these instances could be easily identified and corrected for. This is in contrast to the survey and behavioral observation data, which were far more vulnerable to error due to human factors such as social desirability bias, demand characteristics or errors in observation and self-report. Survey responses, in particular, may have been influenced by the desire to be seen in a positive light, given that the topic of these surveys was something that the organization valued and was actively promoting. Although efforts were made to protect participant anonymity and encourage fidelity in responses, it is possible that participants, either consciously or not, may have distorted their responses based on what was considered most appropriate or desirable. Furthermore, high mean ratings on the conservation goal and outcome expectancy measures, particularly at baseline, suggested that this sample was already highly concerned about this issue and, therefore, may not have been representative of the larger population which was the target of this intervention.

There were also a number of limitations specific to the behavioral observation data. In order to minimize their impact on the behavior of building occupants, researchers were instructed to be as unobtrusive as possible when performing audits. Although this approach has its advantages, it also greatly limited the amount of information that could be recorded within each building. Occupied and unoccupied office spaces, in particular, were difficult to observe and, in many cases, the majority of rooms in a building were inaccessible at the time of measurement, leading to highly variable data. Furthermore, there is reason to believe that building occupants may have been affected by the presence of research staff in the building. On a couple of occasions it was mentioned to the researcher that when an energy audit was being conducted employees would make an extra effort to turn off unused equipment in the building. Likewise, in more than one instance, department heads with good intentions sent e-mails to employees alerting them to the fact that they were being observed. These e-mails were sent to encourage employees to accommodate the researchers by allowing them into private office spaces; however, it is problematic from a measurement perspective.

If, in fact, the findings within the kWh data do best represent the "true" impact of these interventions on behavior, then these inconsistencies are an illustration of why mixed method designs are so critical in social scientific research, particularly in research that attempts to measure behavior. If this evaluation had relied solely on self-report, as is so commonly done in the social sciences, it would have been concluded that both feedback and peer education were ineffective. Certainly there are many situations in which researchers simply do no have access to objective indicators of behavior, or the luxury of using mixed methods at all. Within the environmental behavior literature, there are often a number of options at the researcher's disposal, i.e., kWh consumption, fuel consumption, mileage indictors, etc. These methods tend to be more expensive and timeconsuming in comparison to self-report data; however, the results presented here suggest that they are a critical component to understanding what factors are most effective at motivating pro-environmental behavior. This is particularly important when data are being used to inform public policy, especially with respect to an issue as important and urgent as climate change.

Limitations

A number of limitations were mentioned above regarding the use of self-report and observation to measure behavior, as well as potential biases associated with this sample. This study was additionally limited in its ability to measure psychological variables. Both the measures of conservation goal and outcome expectancy were significantly skewed in the negative direction. Although the analyses used here are robust to violations of normality, the fact that these distributions were negatively skewed suggests the measures were not sensitive enough to discriminate among individuals at the high end of the distribution. Furthermore, ceiling effects can limit a researcher's capacity to examine change over time and may have compromised the validity of these results. Future studies should consider alternative measures, or adjustments to the measures used here, to provide a more accurate estimate of goals and expectancy beliefs.

This study may have been additionally limited due to a lack of statistical power, particularly within the kWh and behavioral observation data. Because there was a constraint on the number of buildings that were eligible for inclusion in this study, the cell size for each treatment condition was very small (n = 6). Multi-level modeling was used to compensate for this fact, which treated the repeated measures as multiple observations within buildings and, therefore, improved power. However, it is likely that type-II error was inflated even with this approach. In cluster-randomized designs statistical power suffers dramatically as the intraclass correlation approaches one. The intraclass correlation coefficient was moderately high to high in both data sets[15] and, as a result, statistical power for small to medium effect sizes reached sub-optimal levels (within the range of 0.3 to 0.6). The fact that significant differences were found, at least within the kWh data, suggests that this may not have been an issue. However, analyses conducted within treatment groups and pairwise comparisons between treatment groups, where sample sizes were reduced, may have been vulnerable to type II error. The findings that were reported here provide justification for a larger study that may be better equipped to examine some of the more subtle differences between treatment groups, as well as moderating factors within groups.

Concluding Remarks

In addition to the contribution of this study to research on behavior change, these data speak to a broader issue concerning the role of social sciences in efforts to reduce the environmental impact of energy use. Climate change, in particular, is a matter of exceeding concern. The projected consequences of this problem, if it is to continue unmitigated, cover the spectrum of political, economic and humanitarian crises. Although there are multiple layers to the causes of climate change, many of which are imbedded in

[15] Within the behavioral observation data, the intraclass correlation ranged from 0.21 to 0.50. Within the kWh data, the intraclass correlation based on the null model was 0.94; however, when the covariates for historical energy consumption were included in the model, this value dropped to 0.54.

industrial and political systems, at its core is the behavior of individual citizens whose decisions ultimately drive and shape these systems. A psychological understanding of the cognitive and social factors that influence individual behavior is a fundamental component of any effort to deal with this problem.

In a recent report prepared for the National Research Council, Stern and Wilbanks (2008) discussed the need for greater research into the “human dimensions” of global environmental change, which has been largely underrepresented thus far. As is evidenced in the work described here, behavioral research has the capacity to offer greater insight into the factors that impact our day-to-day use of energy and, perhaps more important, can provide solutions that may assist us in meeting the targets necessary to mitigate climate change. Recent estimates have found that the direct actions of individuals and households account for 30 to 40% of all carbon dioxide emissions in the United States (Bin & Dowlatabadi, 2005; Vandenbergh & Steinemann, 2007). Furthermore, the work of Gardner and Stern (2008) suggests that a 30% reduction in emissions could be achieved within this group with little to no up-front costs and no loss of personal well-being (i.e., comfort, quality of life). It is clear that solutions to this problem will required a multi-faceted approach, including adjustments to how energy is produced as well as demand for its consumption. However, this work and others suggests there is real opportunity for progress, particularly in meeting near-term targets, by addressing current patterns of consumption using a host of simple, yet empirically-grounded, approaches to behavior modification.

Although this dissertation has focused almost entirely on behavior within the context of its impact on the environment, it is also important to mention that this research has applications that extend well beyond this domain. The psychological factors discussed here are not limited to decision-making in an environmental context and these interventions can be, and have been, used to promote behavior change in a variety of settings (e.g., DiClemente, 1993; Kelly et al., 1991; 1992; May, Rowett, Gilbert, McNeece, & Hurley, 1999). In fact, much of the rationale for the selection of these interventions was grounded in research from other domains, particularly work within the fields of human learning and public health. What this study has shown, in tandem with the other work in the environmental behavior literature, is that these approaches to behavior modification are flexible enough to be applied to new contexts while maintaining their effectiveness. This provides further evidence for the utility of basic social scientific research on behavior, as well as the importance of interdisciplinary efforts in finding creative and effective ways to manage social problems.

APPENDIX A - Example of Informational Postcard

Several weeks ago, we provided tips for how to reduce electricity through temperature control. We are well on our way to meeting our goal of reducing electricity use by **15% or more**. This month we are focusing on achieving this goal by using lighting more efficiently.

Energy Facts:

- Every year Vanderbilt spends over $36 million to provide power to campus.
- Over 20% of our electricity is spent on lighting.
- If just 100 fluorescent fixtures at Vanderbilt were turned off, we could reduce electricity use by over 110,000 kilowatt hours, eliminate 160,000 pounds of CO_2, and save close to $8,000 a year.

What you can do:

- Turn off lights when you leave your office, desk or classroom, even if for only a short time. It uses less energy to turn a light off and on again than it does to leave it on, even for just a few seconds.
- If you have automatic light sensors in your building, make sure they are functioning properly. If not, call Plant Operations to make an adjustment (**2-WORK or 2-9675**).
- On cooler days, open shades and use natural lighting when possible.
- Opt for fluorescent lighting, such as overhead lights or CFL bulbs. Fluorescent bulbs use around 75% less energy than traditional incandescent bulbs and will fit in almost any lamp.
- Assign someone in your department to turn off the lights in common areas, such as classrooms and mailrooms, at the end of the day.

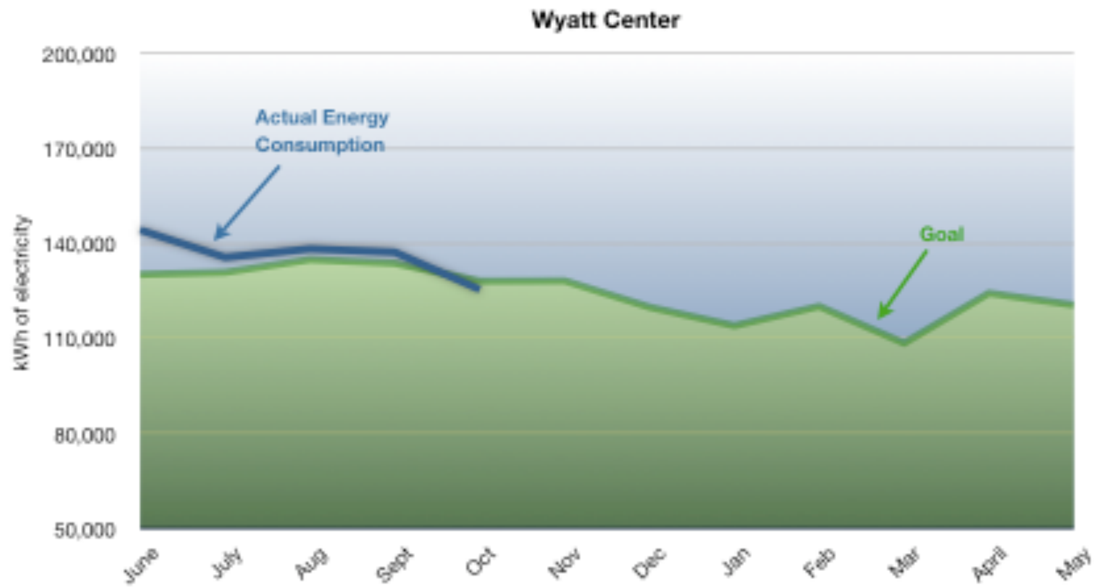
For more information about energy conservation and the ThinkOne campaign, go to www.vanderbilt.edu/SustainVU/ThinkOne

Printed by VU Printing Services using vegetable-based ink on paper that is Forest Stewardship Council (FSC) certified, contains 100% post-consumer waste, is processed chlorine-free and was made by 100% wind-generated electricity. Please recycle

SustainVU

APPENDIX B - Example of Feedback Display

The Sustainability and Environmental Management Office would like to thank you for your efforts to conserve energy. Our campus has made great progress over the past few months. Here is an update on how your building is doing.



In October of 2008 the Wyatt Center used about 125,000 kilowatt hours (kWh) of electricity. This is 17% less energy than is typically used by your building during this time of the year. You've met your goal of reducing energy use by 15% or more. Keep up the good work!

To find out more about the **ThinkOne** campaign, and what you can do to conserve energy, visit our website: http://www.vanderbilt.edu/sustainvu/thinkone/

For more information about this graph and electricity use in your building, please go to: http://www.vanderbilt.edu/sustainvu/thinkone/57479.php

APPENDIX C - Example of Peer Education E-mail Template

Subject: ThinkOne Energy Conservation Campaign: Lights

Thanks to all of you who have joined in the *ThinkOne* challenge of reducing our energy use in the VKC/MRL Building by 15% or more.

Several of you have been turning out your office lights when you step away from your desk, and we are doing a better job of remembering to turn out lights in common areas, such as the staff lounge and restrooms, when we leave those spaces. It is especially important that these lights not remain on unnecessarily over weekends and holidays. When we are leaving the building late on a Friday or on a day before a holiday, let's try to remember to turn out these lights.

During the next few weeks, we are being asked to pay special attention to our use of lights in the workplace. The use of lights accounts for about 22% of all energy that is used on college campuses. The easiest way to save energy is to turn off lights when they are not being used. This is especially important when you leave classrooms, bathrooms, kitchens, or mailrooms where lights are often left on for hours, or sometimes days, while the room is unoccupied.

Contrary to what you may have heard, it uses more energy to leave a light running than it does to turn it off and then back on again. So even if you are leaving your office for a few minutes, you'll save more energy by flipping off the light switch until you get back.

You might also try turning off unnecessary or decorative lighting, using overheads or CFL bulbs rather than the traditional incandescent bulbs, or opening window shades to take advantage of natural light when the weather is not too hot.

If you have any questions or other tips we might try in our building, please let me know.

You can read more about energy conservation here:

http://www.vanderbilt.edu/sustainvu/thinkone/

Your *ThinkOne* Coordinator,

APPENDIX D - Survey Items

Computer Use

(If respondent primarily uses a desktop computer in the workplace)

Do you have the energy-saving settings on your computer turned on? *[no, yes, don't know]*

During the previous work week (monday through friday):

How many days did you power down your computer (including sleep or hibernate) before leaving work for the day? *[0 - 5 days]*

How many days did you turn off your computer monitor (including automatic shut-off) before leaving work for the day? *[0 - 5 days]*

If you have a second monitor hooked up to your computer, how often did you turn this off before leaving work at the end of the day? *[0 - 5 days]*

(If respondent primarily uses a laptop computer)

During the previous work week (monday - friday):

How many days did you leave your laptop running at work after you left for the day? *[0 - 5 days]*

How often did you power down your laptop (including sleep or hibernate modes) when you left your desk for an extended period of time, such as to go to lunch, attend a meeting or run an errand? *[almost never, about 25% of the time, about 50% of the time, about 75% of the time, almost all the time]*

If you have an external monitor hooked up to your laptop, how often did you turn this off at the end of the day? *[0 - 5 days]*

Light Use

Do you personally have lights in your office or desk in addition to the ceiling lights? *[no, yes]*

Please indicate how many.

What type of bulbs do you use*? [incandescent, compact fluorescent, halogen, don't know]*

During the previous work week (monday - friday of last week):

How many days did you turn off the lights in your office or desk before leaving at the end of the day? *[0 - 5 days]*

How many days did you turn off the lights in your office or desk before leaving for an extended period of time <u>during</u> the workday, such as to go to lunch, attend a meeting, or run an errand? *[almost never, about 25% of the time, about 50% of the time, about 75% of the time, almost all the time]*

Heating and Cooling

(If respondent controls his or her own thermostat)

During the previous work week (Monday - Friday):

How many days did you adjust your thermostat before leaving work so that the heat/air would run less while you were not there? [*0 - 5 days*].

Office Equipment

The following questions refer to equipment in your lab or office that you have control over, such as a personal printer, scanner, fan, etc.

During the previous work week (Monday - Friday of last week):

How often did you turn off office or lab equipment when you were finished using it? *[almost never, about 25% of the time, about 50% of the time, about 75% of the time, almost all the time*].

Do you have any appliances or equipment in your office, lab, or workspace that you use infrequently (2-3 times a week or less), such as a coffee maker, fan or second computer? [*no, yes*]

Please indicate how many.

How many of these appliances are currently unplugged?

Outcome Expectancy

Please rate your level of agreement with the following statements. [Responses were made on a 5-point scale ranging from *disagree strongly* to *agree strongly*].

The amount of energy that Vanderbilt consumes depends more on what the university administration decides than the practices of employees and students. [RC]

Whether or not I personally reduce the amount of energy I use will have no real impact on the amount of energy that Vanderbilt consumes. [RC]

My personal actions can reduce Vanderbilt's level of energy consumption.

By changing our behavior, employees and students like me can reduce Vanderbilt's energy use.

Conservation Goal

Please rate your level of agreement with the following statements. [Responses were made on a 5-point scale ranging from *disagree strongly* to *agree strongly*].

Vanderbilt should do more to save energy.

I am concerned about the amount of energy that Vanderbilt uses.

Energy conservation should not be a priority at Vanderbilt right now. [RC]

I would like to reduce the amount of energy that I personally use at Vanderbilt.

Descriptive Norm

[Response options include: *very few, about 25%, about 50%, about 75%, nearly everyone*]

How many people in your building power down their computers and/or monitors before leaving work for the day (please give your best guess)?

How many people in your building turn off the lights at their desk/office before leaving work (please give your best guess)?

How many people in your building turn off office or lab equipment when they are finished using it (please give your best guess)?

How many people in your building adjust their thermostats to run less when they are not at work (please give your best guess)?

Injunctive Norm

[Response options include: *strongly disapprove, disapprove somewhat, neither approve nor disapprove, approve somewhat,* and *strongly approve*]

If other people in your building saw that a computer and/or monitor was left on when the user was not at work, they would:

If the other people in your building saw that an individual's lights were left on when he/she was not at work, they would:

If the other people in your building saw that office or lab equipment had been left on when it was not in use, they would:

If the other people in your building saw that an individual did not adjust his/her thermostat to run less when he/she was not at work, they would:

Organizational Identity

[Responses range from 1 = *disagree strongly* to 5 = *agree strongly*]

When someone criticizes Vanderbilt, it feels like a personal insult.

I am very interested in what others think about Vanderbilt

When I talk about the university, I usually say 'we' rather than 'they'.

Vanderbilt's successes are my successes.

When someone praises Vanderbilt, it feels like a personal compliment.

If a story in the media criticized the university, I would feel embarrassed.

Campaign Exposure

Were you aware of a campus-wide energy conservation campaign that took place during the last few months? [*no, yes*]

(If 'yes') Did you receive any information in your campus mailbox, such as a postcard or flier? [*no, yes, not sure*]

(If yes) How often did you read this material? [*never, sometimes, always*]

Did you receive any e-mails regarding energy conservation from members of your department? [*no, yes, not sure*]

(If yes) How often did you read this information? [*never, sometimes, always*]

Did you receive any statistics or graphs about the amount of electricity that your building used? [*no, yes, not sure*]

(If yes) How often did you read this information? [*never, sometimes, always*]

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