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COMPARING GOAL SETTING APPROACHES TO BOOST COMPUTER-RELATED PRO-ENVIRONMENTAL BEHAVIORS

Research Paper

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Abstract

This research focuses on improving individuals' pro-environmental behaviors related to information technology and system use. To do so, we draw on and extend goal-setting theory by comparing three goal interventions: goal-setting, goal-setting plus implementation plans, and goal-setting with both implementation plans and visualization of success. Two longitudinal studies examine individuals' self-set goals: the first examines employees' computer-based electricity usage in the workplace over six weeks and the second utilizes a diary approach method over four weeks to examine the effects of different goal setting conditions on students' environmental outcomes. Both studies find that setting goals increases pro-environmental behaviors. However, rebound effects can occur when interventions are removed. Visualization of success appears to reduce this rebound effect and we suggest that future research continue to investigate methods for reducing rebound, including the roles of values and multiple goals on the efficacy of goal-setting. This paper contributes to Green IS research in several ways: conceptually (by responding to calls for more theory-based research), methodologically (by measuring objective computer-based energy usage in study 1 and by utilizing a diary method in study 2), and practically (by demonstrating the effectiveness of visualization to goal setting).

Keywords: Green IS, Pro-Environmental Behavior, Goal setting, Field experiment, Rebound

1 Introduction

This research focuses on improving employees' pro-environmental behaviors (PEBs) related to information technologies and systems (IS). Environmentally responsible behaviors in organizations, or PEBs, represent any actions taken by employees that they believe would improve the environmental performance of the organization (Ramus and Steger, 2000). Specific to IS, these PEBs might include behaviors such as substituting desktop videoconferencing for travel, turning off computer equipment when not in use, choosing new equipment based on its environmental footprint, printing wisely, donating or recycling old equipment, and influencing coworkers to do the same.

Green IS research can be considered from two perspectives, as a contributor or as a solution to environmental degradation (Berthon and Donnellan, 2011; Elliot, 2011; Seidel et al., 2013). For example, from the first perspective, we might investigate reducing electricity consumption of computers, and from the second, we might develop software to help change beliefs about environmental sustainability. The studies presented in our paper fall in the first category, that is, they examine the reduction of environmental impacts of using computer-based systems. It is important to examine ways to reduce energy to enhance sustainability because the amount of electricity used by devices plugged into outlets in buildings is significant so. Currently, 33% of electricity use in residential and commercial buildings is from plug load, and this is expected to rise to 49% by 2030 (Orland et al., 2014).

Most past Green IS research has been conducted at the organization level (El Idrissi and Corbett, 2016; Wang et al., 2015). These top-down initiatives represent a key part of solving the greening puzzle.

zle (e.g., Molla and Abareshi, 2012), yet bottom-up interventions are also needed. Focusing on employees has high potential for impact since employee behaviors facilitate corporate social responsibility initiatives and organizational efforts to protect the environment (Bissing-Olson et al., 2013). All employees consume materials and energy in their workplaces and they can influence others to adopt behaviors that are better for the environment (Smith and O'Sullivan, 2012). Focusing on individuals is important, as their effects can go well beyond themselves (Swim et al., 2010). For example, research has demonstrated that individual employees can have significant effects on the environmental sustainability of IS projects, even when their organizations' management has no interest in sustainability (Corbett et al., in press). However, research that investigates employees' pro-environmental behaviors is scarce and needed (Lo et al., 2012; Robertson and Barling, 2013). In contrast, most PEB research at the individual level has been conducted in households, rather than in organizations (Osbaldeston and Schott, 2012). Further, past research tends to show a lack of long-term effects (Gollwitzer and Sheeran, 2006).

In our research, we focus on goal setting. Although a meta-analysis suggests that goal setting represents one of the most-impactful interventions for sustainability (Osbaldeston and Schott, 2012), it has received little attention for encouraging sustainability in general (Osbaldeston and Schott, 2012) or for Green IS in particular (Seidel et al., 2013). Even though goal-setting is considered a valid and practical motivational theory often applied in the workplace (Locke and Latham, 2002), most previous sustainability studies have focused on household settings (e.g., Abrahamse et al., 2005; Van Houwelingen and Van Raaij, 1989). Moreover, goal setting is often combined with other interventions so that its specific effects cannot be determined (e.g., Hamad et al., 1980; Kopp and McCaul, 1982; McCalley and Midden, 2002). Goal setting has also been used to study non-green IS topics such as decision support systems and software project management (Loock et al., 2013).

In the Green IS area, Seidel et al. (2013) emphasize the importance of both management goal-setting and user goals for sustainable work practices and call for further research in this area. Additionally, Loock et al. (2013) call for more research on environmental interventions that draw on socio-psychological theories and that utilize longitudinal experimental designs. Thus, to address the limitations of past studies, the present research focuses on whether goal setting is effective in encouraging PEBs and how the effects of goal-setting can be prolonged. To do so, we examine PEBs, such as computer-related energy savings, via two longitudinal experimental studies. The details of these studies and their findings are described below; before doing so, the next section provides a brief overview of goal-setting theory and then explains the hypotheses examined in our studies.

2 Goal Setting to Increase Pro-Environmental Behaviors

In this research, we focus on how individuals can change their computer-related behaviors, that is, on Elliot's (2011, p. 32) proposition that "*Human beings can change their behavior to have a less negative impact on the environment*". To do so, we focus on interventions that can help conserve environmental resources. Interventions are generally categorized into a range of manipulations, ranging from more passive ones, like ease of use, to more engaging ones, like goal setting. Goal setting represents one of the most effective, yet understudied, interventions for environmental sustainability (Osbaldeston and Schott, 2012). Thus our studies draw on goal-setting theory to examine the effects of setting PEB-related goals.

2.1 Goal Setting Theory Background

Goal setting theory is a middle-range theory, in that it is close enough to data to enable empirical validation while abstract enough to allow for generalizations (Hassan and Lowry, 2015). This theory was formulated in the 1960s by Edwin Locke and is still undergoing development to the present day (e.g., Locke and Latham, 2002; Latham et al., 2010). It has emerged as a powerful, reliable theory to predict, influence and explain human behavior (Locke and Latham, 2002). Consciously setting a goal,

depending on the circumstances, can motivate individuals, resulting in changes in behavior. Goal setting creates obligations and intentions to attain a goal or desired behavior, so that individuals' attention is regulated towards goal-related activities over longer periods of time (Miner, 2005).

Behaviors result from individual cognition and motivation, and goals can influence behavior via motivational mechanisms (Unsworth et al., 2014). There are four causal mechanisms identified in goal setting theory. First, committing to a goal focuses attention and effort on goal-relevant activities and away from other activities. Being aware of a specific goal provides purpose and directs activity. Second, challenging goals can energize people and cause higher effort than easy goals. This finding has been found for both goals that require physical and cognitive effort (Latham, 2004). A positive, linear relationship has been observed between goal difficulty and performance, up to the point where the goal exceeds an individual's ability (Locke and Latham, 2002). At that point, performance levels off and eventually decreases. Third, setting challenging goals can increase persistence and prolong effort. Fourth, goals affect action by motivating people to use the knowledge they have relevant to the task and/or discover the knowledge and strategies needed.

Research has found several important moderating factors on the relationship between goal setting and behavior (Locke and Latham, 2002). When people are committed to the goals they set, the goal-behavior relationship is strongest. Commitment is strong when people believe the outcomes related to the goal are important to them and believe they can attain the goal (self-efficacy beliefs). Feedback is another important moderator. Feedback on goal progress allows individuals to adjust their efforts and/or strategies to fit what is needed to reach the goal. A third goal-effects moderator is the complexity of the task. The effects of goal setting depend on a person's ability to discover appropriate task strategies. The effect size for goal setting is smaller on complex tasks versus simple tasks because people vary in their ability to develop effective goal strategies.

Individuals are likely to have multiple goals active at any given time. Goals can interact with each other for attention and resources and may be complimentary or in conflict. Researchers have developed different classification schemes for goals. Kruglanski et al. (2002) present a system of goals to help explain cognition and resulting motivation. Their goal system has three levels (from highest to lowest): goals, sub-goals, and means (to accomplish the goal). Unsworth, Yeo and Beck (2014) describe a four-level goal hierarchy (from lowest, shortest-term to highest-order, longer term): tasks (similar to Kruglanski et al.'s means), project goals, identities, and values. Lindenberg and Steg (2007) proposed three different types of goals that are inclusive in terms of including sub-goal areas, knowledge and attitudes. These were hedonic goals (ways to improve how one feels in a given situation), gain goals (to protect and improve one's personal resources), and normative goals (to act appropriately, with respect to what one thinks one ought to do). These three goals direct attention and influence the information noticed, what knowledge is accessible, what alternatives are considered, and how people act (Steg et al., 2014).

Turning to the Green IS research area, few Green IS studies have focused on goal-setting. Exceptions include a study by Loock et al. (2013) that examined the energy use of a large number of households over 4.5 months. In this study, they used a web portal providing energy feedback along with self-set and/or default goals. Their results demonstrate that households setting goals for electricity consumption used less energy than those who did not. In terms of defaults, only medium-level defaults led to significant savings: this is because individuals may adjust their goals downward with low default goals and may become discouraged with high default goals.

Another Green IS study examining goals is one by Ebermann and Brauer (2016): they examined whether bikers' perceptions of multiple hedonic, gain, and normative goals appeared relevant at the beginning of a 21-day period, and related those goals to the use of a gamified website and biking distance during that period. They found that participants who indicated that competition was a relevant goal were more likely to access the gamified website elements of rankings and mileage display, while those with the goal of climate protection were more likely to access the CO₂ savings display. In terms of biking distance, they examined a variety of goal combinations: they found that competition com-

bined with climate protection goals resulted in greater distance travelled than single or no goals. However, they did not study goal setting as an intervention and call for more research in controlled settings (Ebermann and Brauer, 2016). Our hypotheses, described below, help to address this gap.

2.2 Setting Pro-Environmental Goals

Goal-setting theory provides the underlying mechanism for goal-setting interventions (Osbaldeston and Schott, 2003). Goal setting interventions usually ask individuals to aim for an assigned or self-set goal, such as saving 15% in energy consumption. For example, studies focusing on energy conservation (e.g., Abrahamse et al., 2007; Becker, 1978; Loock et al., 2013; McCalley and Midden, 2002; Van Houwelingen and Van Raaij, 1989) demonstrate that goal setting represents an effective way to reduce energy consumption and that adding feedback strengthens its effectiveness. While these studies were set in the context of energy consumption for individuals at home, we explore whether goal setting will have similar effects in the workplace.

On the one hand, organizational factors such as power relations, group influences, reward structures, competing goals, and corporate norms and values create a different context than private life. This may alter the effects of any intervention. For example, an individual citizen (i.e., a person who acts individually or within a family unit) prompting a friend to recycle may be perceived as a gentle reminder while a boss prompting his employee to recycle may be perceived as an admonishment or reprimand: this means that the organizational recycling reminder will likely lead to different outcomes than the recycling reminder in one's personal life. On the other hand, in contrast to citizens, employees can have wider-ranging influences. Not only may their own behaviors change, but they may also influence their peers and managers to act more responsibly (Smith and O'Sullivan, 2012). Thus, we suggest:

H1: Setting goals for improving the environment will increase pro-environmental behaviors as compared with no goal setting.

Although goal-setting interventions are potentially effective, the behavior change may not continue once the intervention stops (Hamad et al., 1980). Therefore, researchers have proposed several enhancements to goal-setting, including making plans and visualizing success.

2.3 Making Implementation Plans

Even though setting a goal is the key component that prompts goal achievement, having a goal does not guarantee its successful accomplishment. That is, goal setting helps people form intentions to perform particular behaviors, but a substantial gap often exists between peoples' goal intentions and their subsequent goal achievements (Gollwitzer and Sheeran, 2006). Gollwitzer and Brandstätter (1997) proposed the concept of implementation plans to improve goal achievement and there is considerable evidence that planning how to achieve a goal does help to predict goal attainment (Unsworth et al., 2014). Specifically, the goal requires an if-then plan specifying when, where, and how to carry out goal-related behaviors that should promote successful goal attainment. The if-then plan takes the format of: 'If situation A occurs, then I will begin goal-directed behavior B' (e.g., "if I leave my desk at work, then I will turn off my computer screen"). To form an implementation plan, one must identify a behavioral response that will encourage goal achievement (the then-component) and determine a suitable situation to carry out that response (the if-component) (Gollwitzer and Sheeran, 2006).

Implementation plans mimic the mechanism responsible for habitual processes and the aim is to attain goals without conscious thoughts (Gollwitzer, 1999). That is, after forming implementation plans, individuals should perform the desired behavior automatically using pre-determined responses when the situations occur (Gollwitzer and Sheeran, 2006). Therefore, conscious planning is critical to initiate the goal-related behaviors and further facilitates the forming of long-term habitual PEBs (Holland et al., 2006). Several studies have shown the effectiveness of implementation plans in areas such as transportation, recycling, and organic food purchasing (Aarts and Dijksterhuis, 2000; Bamberg, 2000, 2002; Fennis et al., 2011; Rise et al., 2003). Developing effective task strategies related to specific

goals is an important determinant of goal success (Locke and Latham, 2002), potentially increasing goal intensity and enhancing goal commitment (Locke and Latham, 1990). Thus, we hypothesize that:

H2: Goal setting plus implementation plans will increase pro-environmental behaviors as compared with only goal setting.

2.4 Visualizing Success

Although implementation plans have promise for increasing PEBs, these plans may not result in long-term behavior change. The well-known rebound effect can occur when the individual performs PEBs initially but later switches to other goals, resulting in lower PEBs (Unsworth et al., 2013). However, having individuals visualize successfully implementing their plans may help in this regard. For example, Koestner et al. (2008) suggest that individuals should list specific obstacles to reaching their goals and then should develop strategies for managing these obstacles. Further, Dalton and Spiller (2012) propose that participants should rehearse their plans. Finally, Schultheiss and Brunstein (1999, p. 31) suggest that using an imagery exercise helps “make participants anticipate experientially what they are instructed to do”. This has the potential to enhance a participant’s goal self-efficacy (i.e., task-specific confidence), which has been positively linked to goal commitment and goal performance (Locke and Latham, 2002). Thus, we suggest that describing obstacles, developing strategies to address these obstacles, and visualizing successfully overcoming these obstacles will help to minimize the rebound effect, thereby increasing PEBs.

H3: Adding visualizing success to goal setting plus implementation plans will increase pro-environmental behaviors as compared with only goal setting plus implementation plans.

To examine these hypotheses, two studies were conducted. The first, examining hypotheses 1 and 2, was a six-week study of computer-related energy use by employees. In it, we observed the rebound effect. Thus, we conducted a second study focusing on understanding more about this effect. This study, examining hypotheses 1 through 3 over a four-week period, examined computer-related and other PEBs by students.

3 Study 1

This study examined employees’ computer-based electricity usage in the workplace over six weeks. Before conducting it, we piloted our materials with seven individuals, and then pretested them in a 1.5 hour office simulation experiment with 40 undergraduate business students. The students were randomly assigned to control, goal setting, or goal setting + plans conditions (as described below for the main study), and then completed a series of office tasks on computers. Their electricity usage was monitored with a wattmeter and hypotheses 1 and 2 were supported. Specifically, an ANCOVA (with laptop versus desktop as a covariate) demonstrated a difference in electricity usage between the three conditions ($F = 5.26$, $p < 0.05$; mean electricity usage (control) = 35.00 watts, mean (goal-setting) = 31.67 watts, mean (goal-setting + plans) = 30.00), although the two goal setting conditions were close. Thus, H1 was supported for goal-setting but goal setting + plans appear to have marginal improvement over goal-setting (H2).

For the main study, participants were employees who used computers regularly at work. A convenience sample of sixteen employees from several organizations (university, security, auto parts, and engineering) participated: the average age was 55, 56% were female, and 73% had a university education.

3.1 Procedure

Unlike the pretest (a between-subjects design), this study was a field experiment using a between- and within-subjects design (two goal-setting conditions, with each participant acting as his/her own control). The first two weeks of the study represented the control period, during weeks 3 and 4 partici-

pants were randomly assigned to either the goal or goal + plans condition, and weeks 5 and 6 were the post-condition period.

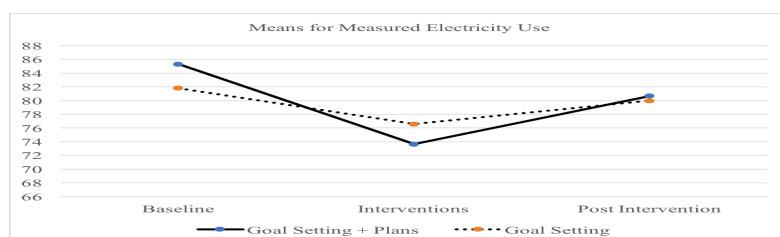
On day 1, participants completed a background survey on their demographics. Then, a watt meter, a power bar, and an electricity recording chart were provided. We plugged all computers and computer-related devices, such as printers, external monitors, and speakers, into the extension cord and then connected it to the watt meter. The extension cord and watt meter were placed on participants' desks to provide accessibility. Participants were asked to record the reading from their watt meters at the beginning and end of each workday. Using this data from the first two weeks, we were able to calculate typical (pre-intervention) energy usage for each participant: that is, we could establish a baseline of the average amount of electricity consumed by each participant for control purposes.

For the next two weeks, participants were assigned to one of the two interventions: a goal setting or a goal setting plus implementation plans. Goal-setting condition participants set goals to consume less electricity with computers; participants in the goal-setting plus implementation plans condition also set goals and then made plans on ways to implement these goals. To facilitate setting goals and making plans, a list of tips on saving electricity consumed by computer-related equipment was provided to all participants. This list of six electricity-saving tips (such as "turn off any peripheral devices (e.g., printer) when not in use") were taken from a review of the popular literature¹. Participants were asked to choose at least three tips that they usually did not perform, set electricity-saving goals based on the tips, and write down the goals on a form. One example was provided on the form: "I agree to my goal of conserving electricity on my computer and computer-related devices, and will do so by dimming my screen brightness." For the goal-setting plus implementation plans condition, participants also designed situations / opportunities to act on the goals they chose and wrote down these plans and initialled them to indicate agreement. The example listed on the form was "If I leave my desk, then I will turn off my monitor." For both conditions, their goal forms were left on their desks for the next two weeks to enhance attention and goal saliency.

Two weeks later, the goal forms were collected. Participants continued to record twice-daily electricity consumption for another two weeks.

3.2 Results

The amount of electricity used by employees was subjected to a factorial (two conditions) repeated-measures (three time periods) analysis of variance. There were main effects for time ($p < 0.05$), but the two conditions did not differ ($p > .10$). The statistically significant change in electricity consumption was generated from the baseline period (weeks 1 & 2) to the intervention period (weeks 3 & 4). For the post-intervention period (weeks 4 & 5), mean electricity usage increased but remained lower than the baseline period (see Figure 1).



¹ To create this list, we hired two research assistants from Environmental Sustainability who reviewed the practice literature (e.g., <https://energy.gov/energysaver/energy-efficient-computers-home-office-equipment-and-electronics>; <https://www.ghacks.net/2009/05/29/7-computer-energy-saving-tips/>). In addition, we conducted a brainstorming session with executives, asking them for tips. We selected tips that could be implemented by individuals (rather than by organizations).

Figure 1. Study 1 Energy Usage across Time Periods

These results demonstrate support for H1, but not for H2 (that is, there is no difference between the goal setting and goal-setting + plans conditions). Further, findings support the effects of goal-setting in the short-term (the difference between the first two time periods), but demonstrate a rebound effect when the interventions are removed (for the last time period). Thus, examining whether visualization (H3) might relate to the rebound effect was the purpose of the next study.

4 Study 2

Over a period of 4 weeks, a longitudinal, diary approach method was used to examine the effects of different goal setting conditions on PEBs. We incorporated four conditions in our experiment: control, goal-setting, goal-setting + plans, and goal-setting + plans + visualization. The three goal-setting conditions concerned setting environmental goals (the most frequent goal category chosen by students was computer-related), while the control condition set a wellness goal. We included a wellness goal to help minimize hypothesis guessing (Trochim, 2006): that is, participants were told that they would be randomly assigned to a wellness or environmental condition.

Participants were undergraduate business students in a North American university. Recruitment was done through the school's subject pool (participating students received course credit, as well as the possibility of winning a draw for a bookstore gift certificate). A total of 166 students participated, with the breakdown across conditions 1 to 4 being 39, 46, 42, and 39, respectively. Before the main study, a pre-test was conducted with three other students to refine the materials and procedures.

4.1 Procedure

At time zero, participants met with the researchers face-to-face and completed a paper-based questionnaire measuring several control and demographic variables (see Figure 2 for a summary of the study procedures). They were then randomly assigned to one of the four treatment groups in which they set a daily goal, such as "Read documents online instead of printing (when possible)" or "Turn off external devices for computer when not in use for more than 15 minutes (computer monitor)". In condition 1, they set a wellness goal. Condition 2 participants set an environmental goal. Condition 3 participants set an environmental goal and then also defined three goal implementation plans (as in Study 1). Condition 4 participants did everything in condition 3 but also defined three barriers/distractions to reaching their goals and corresponding strategies to overcome these barriers; they also visualized themselves using these strategies to overcome the barriers and reach their goals. Over the three environmental goal conditions, 34% of the participants chose computer-related environmental goals.

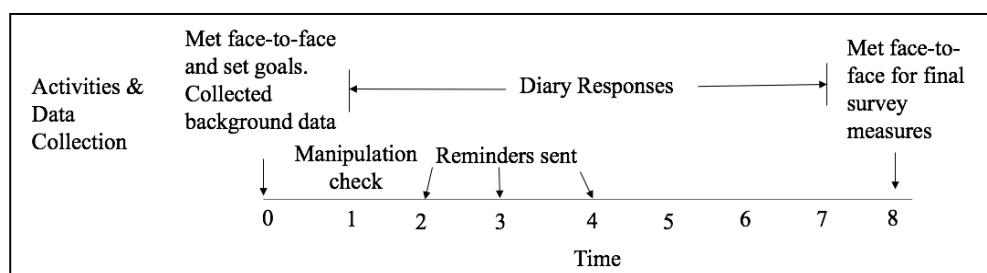


Figure 2: Study 2 Design

During the next four weeks, participants completed seven short electronic diary surveys (about one every 3 days) that asked about their progress in reaching their goals, their commitment to their goals, and their goal attainment (times 1 to 7). As is typical with diary studies, these online surveys used single-item measures to keep them short (Bissing-Olson et al., 2015). Progress was measured using a 0 to 100 slider scale asking the following question: "On the slider below, please indicate how well you

have met your daily goal over the past several days” (adapted from Koestner et al., 2002). For Commitment, a 9-point scale was used, asking “How committed do you feel towards this goal?” (Koestner et al., 2002). Goal Attainment utilized a 9-point scale to ask “How well do you feel you are attaining your goal?” (Sheldon and Schöler, 2011). In the surveys for times 2 to 4, respondents were provided with reminders of the goals they had set. Conditions 3 and 4 also received reminders of their plans at T3, and condition 4 received a reminder of their possible distractions and strategies at T4.

At the end of week 4 (time 8), participants met with the researchers again face-to-face to complete a final paper-based survey assessing dependent variables. Specifically, we assessed their perceived goal satisfaction (7 items, $\alpha = .82$) by asking “To what extent do you feel each of the following emotions regarding your current standing on this goal?” on a 9-point scale with items such as “Dissatisfied” (reverse-scored). We also measured their organizational citizenship behavior for the environment during the study (Boiral and Paillé, 2012; 11 items, $\alpha = .91$) by asking “For each of the following behaviors over the last 3 weeks, please indicate your level of disagreement or agreement” on a 9-point scale, listing items such as “I encouraged others to adopt more environmentally conscious behaviors”.

4.2 Results

We first screened for several analysis assumptions. In terms of required sample size, we conducted a power analysis in G*Power (Faul et al., 2007) for a MANOVA with four conditions and two dependent variables (using an alpha of 0.05, a power of 0.80, and a medium effect size of $f = 0.25$). Based on these assumptions, the desired sample size is 116 (as compared to our actual size of 166 participants). To check the efficacy of our manipulation, we asked participants at time 1 to describe the goal they had set at T0: 89.2% of participants accurately recalled their goal. Further, an analysis of univariate and multivariate outliers indicated one multivariate outlier that we deleted from our data set.

To determine whether condition affected the DVs of goal satisfaction and environmental citizenship (H1-H3), we conducted a MANOVA (using the SPSS procedure General Linear Model - Multivariate). The overall test was significant (Wilks' lambda = 0.87; $p < .001$), and Condition related significantly to both goal satisfaction ($F=4.33$; $p < .01$; means of 5.00, 5.56, 5.44, and 6.12, for conditions 1-4, respectively) and environmental citizenship ($F=4.11$; $p < .01$; means of 3.07, 4.00, 4.08, and 4.09). Although the means are generally in the expected direction, a Bonferroni analysis demonstrates that all do not differ significantly from each other. Thus, there is some support for H1 through H3, but it is not clear whether the environmental conditions differ from each other. We next examined the diary data over the 7 time periods to determine whether differences between the environmental conditions exist.

For each of the three constructs measured over T1 to T7 (Progress, Commitment and Goal Attainment), a mixed ANOVA analysis was conducted for repeated measures (using the SPSS procedure General Linear Model - Repeated Measures). Mauchly's test of sphericity indicated that the assumption of sphericity had been violated in the analyses of the three outcome variables. Therefore, the degrees of freedom were corrected using Greenhouse-Geisser estimates (and are reported in Table 1).

To investigate Hypothesis 3 (the effect of defining goal distractions, strategies to overcome these distractions, and visualizing these working), we compared the results for this condition to the other two environmental conditions (by combining them, as there were no significant differences between them, as indicated in the previous pairwise Bonferroni analysis). The main effect of goal progress and the interaction effect of goal progress by condition type were both significant ($F = 2.98$, $p=0.02$; $F= 3.10$, $p= 0.01$, respectively). The main effect of condition type was non-significant ($F= 0.41$, $p= 0.53$). See Table 1 for more details and Figure 3, panel 1 for the patterns of goal progress over time. The means of the two conditions at T7 were statistically different (unpaired t-test: $t=-2.47$, $p=0.01$).

	Type III Sum of Squares	df	Mean Square	F	Sig.
Goal Progress:					

Test of Within-Subject Effect					
Progress – main effect	3157.19	4.32	731.50	2.98	0.02
Progress x condition – interaction effect	3282.35	4.32	760.50	3.10	0.01
Test of Between-Subject Effect					
Condition – main effect	907.67	1	907.67	0.41	0.53
Goal Commitment:					
Test of Within-Subject Effect					
Progress – main effect	6.84	3.96	1.73	1.06	0.37
Progress x condition – interaction effect	18.26	3.96	4.61	2.84	0.03
Test of Between-Subject Effect					
Condition – main effect	0.01	1	0.01	0.00	0.99
Goal Attainment:					
Test of Within-Subject Effect					
Progress – main effect	23.37	4.55	5.13	2.79	0.02
Progress x condition – interaction effect	20.04	4.55	4.40	2.39	0.04
Test of Between-Subject Effect					
Condition – main effect	1.80	1	1.80	0.10	0.75

Table 1: Testing Differences in Conditions over Time Periods 1 to 7

The interaction effect of commitment by condition type was significant ($F = 2.84$, $p = 0.03$): see Figure 3, panel 2, for the patterns over time. However, the main effects of condition type and goal commitment were both non-significant ($F = 0.00$, $p = 0.99$; $F = 1.06$, $p = 0.37$, respectively). Although the slopes appear to be different for commitment in panel 2, the mean differences at T7 were non-significant (unpaired t-test: $t = -1.45$, $p = 0.15$).

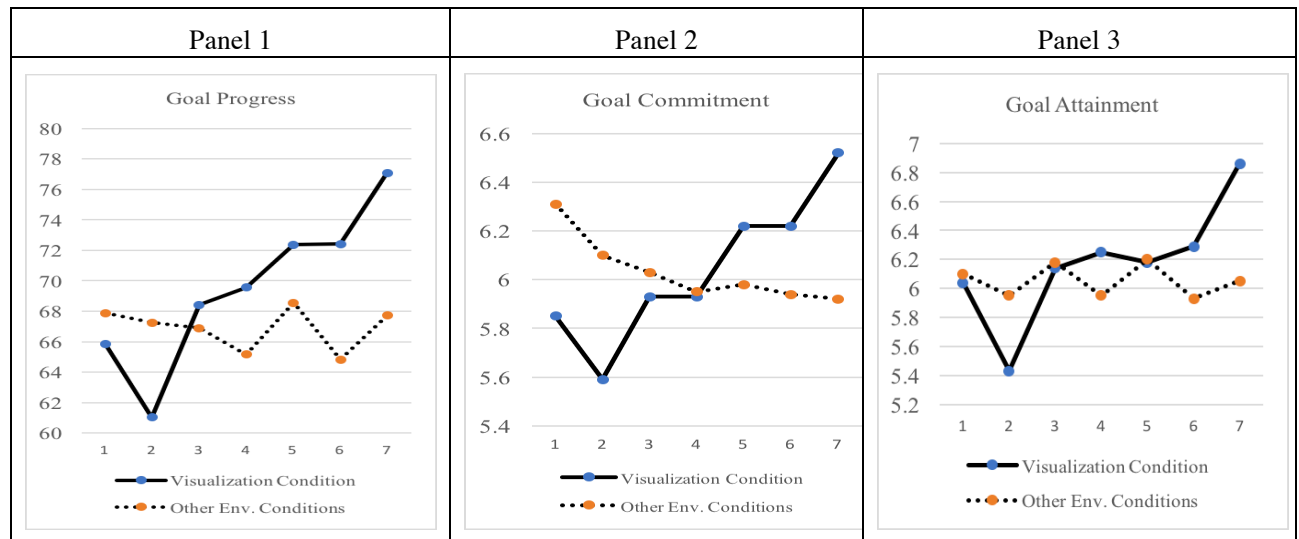


Figure 3. Study 2 Goal Perceptions across Time Periods

The main effect of goal attainment was significant ($F = 2.79$, $p = 0.02$), as was the interaction effect of goal attainment by condition type ($F = 2.39$, $p = 0.04$). The main effect of condition was non-significant ($F = 0.10$, $p = 0.75$). See Figure 3, panel 3 for the patterns of goal attainment over time. This shows that participants in the visualization condition reached their goals more often than participants in the other conditions (unpaired t-test: $t = -2.08$, $p = 0.04$). In summary, it appears that visualization has potential for reducing rebound effects.

5 Discussion and Conclusions

This research responds to calls for more Green IS studies (e.g., Jenkin et al., 2011; Watson et al., 2010) and investigations of the role of goals in particular (e.g., Seidel et al., 2013). Unlike most past empirical Green IS research that has been largely atheoretical (Elliot, 2011; Wang et al., 2015), we drew on and extended goal-setting theory to explore how to conserve environmental resources arising from the use of computer-related systems. Unlike other studies that do not perform interventions, but instead ask participants to indicate multiple goals that might be relevant for them (e.g., Ebermann and Brauer, 2016), we conducted controlled experiments. To do so, we did not assign goals, but allowed participants to select their own from suggestions we provided, making these ‘their own goals’ and helping to ensure that they would be committed to them (Locke and Latham, 2002).

Consistent with goal-setting theory, Study 1 found that PEBs increased after setting environment-related goals. In that study, we found that computer-related pro-environmental behaviors increased after setting environmental goals: goal behavior was maintained during the intervention period, possibly due to the attention and saliency created by having accessible goal prompts. After these prompts were removed, PEB behaviors declined. This decline could have been due to participants pursuing other goals and behaviors; this is not very surprising as they would have had many goals relevant to their professional and personal lives. Unsworth et al.’s (2013) model of psychological conditions underlying PEB change suggests several explanations for these findings. That is, long-term goal activation depends on several things, including the fit with the individual’s values and beliefs (a stronger fit increases motivation), behavioral expectations from other sources (potentially creating goal conflict), and perceived abilities to achieve the goal (goal efficacy).

Our research found little support for the hypothesis that setting implementation plans for achieving a goal strengthens resulting behaviors over and above goal-setting itself. However, our second study suggests that visualizing success may improve progress in meeting goals, presumably by strengthening goal efficacy. Participants in condition 4, who identified barriers, strategies to overcome the barriers, and visualized being successful in these strategies, continued to be more successful in reaching their goals (see Figure 3). This suggests that visualizing themselves overcoming obstacles has stronger and longer-lasting effects than simply defining plans to reach goals. More research is needed to examine the effects of imagery and visualization interventions in setting goals in differing contexts (Chan and Cameron, 2012).

5.1 Strengths and Limitations

This research offers contributions to Green IS and other fields more generally. Our studies have a number of strengths, including allowing participants to set their own goals, longitudinal data collection, and objective goal attainment data (for Study 1). Study 2 contributes methodologically by using a ‘diary study’/experience sampling method. Although the diary method is rarely used in IS, it has several advantages. Participants do not need to recall information but instead report on their current activities and thoughts as they occur (Csikszentmihalyi et al., 2003). This minimizes recall bias (Schwenk, 1985) and thus is preferable to retrospective reports (Elfenbein, 2007). However, unlike most diary studies that are ‘passive’ in nature (examining what happens over time), we conducted an experiment for our diary study. Diary studies that are designed as experiments are more powerful, improving the internal validity of the research (Beal, 2015).

This research also responds to calls for more research on goal-setting in environmental research (Osbaldeston and Schott, 2012) and for more research on improving goal-setting, such as using goal imagery (Schultheiss and Brunstein, 1999, p. 32). This paper also contributes to goal-setting research more generally. Most goal-setting studies in psychology and management have been conducted in isolation (Latham et al., 2010), yet we draw on both fields (e.g., Koestner et al., 2008; Unsworth et al., 2013). For Green IS research, the findings suggest that goal setting does have the potential to change employees’ computer-related behaviors and thereby reduce an organization’s environmental impact.

We anticipate that future research will yield further insights into how to strengthen the impact of goal setting and other interventions on computer-related environmental behaviors.

Nevertheless, both studies have limitations. Study 1 has a small sample size, yet we collected objective energy data for employees over 6 weeks. In terms of Study 1 goals, we suggested six electricity saving tips based on the practice literature, but did not ask participants for their perceptions of these tips. Future research should address this limitation by examining the fit of these goals with participants' values. Study 2 utilized students, but we were able to track their goal attainment over 4 weeks. For this study, it could have been the case that students responded in socially desirable ways (we did not collect objective data, as in Study 1). However, because of our experimental design, this would be less of a concern because it would potentially apply equally to all of our conditions. In addition, socially desirable responding is less likely when participants are randomly assigned to conditions and anonymity and confidentiality are promised (Paulhus, 1991). Another potential limitation for both studies concerns collecting data from participants over multiple time periods, which could have reminded them of their goals and reinforced the goals' effects. For instance, having employees periodically record their energy use from the wattmeter can represent a type of feedback: although feedback is an important component of goal-setting, it would serve to remind participants of the study.

5.2 Implications for Research and Practice

Our studies have implications for both research and practice. Goal setting theory specifies that setting goals is an effective way to create motivation and direct attention and resources towards goal-related tasks. We suggest that we contribute to this mid-range theory by adding testable generalizations about how to extend the effective duration of setting a goal. Specifically, the effectiveness of setting goals on outcomes depends on the ability of an individual to work towards the task. Developing implementation plans can help make these abilities salient; however, our studies found little difference in the effectiveness of setting goals alone, versus setting goals and making plans. Study 1 found that both interventions did have a positive effect during the treatment period, but that effects diminished post-treatment. Looking at Study 2 patterns in Figure 3 for setting goals and goals with plans (the dashed line for Other Env. Conditions), we see similar results: a pattern where progress and goal attainment were again relatively flat during the duration of the study (but, a stronger result than the control group). In contrast, when participants identified goal barriers, strategies to overcome the barriers, and then visualized themselves successfully using these barriers, a different pattern of performance emerged. Goal performance and commitment were stronger at the end of the Study 2. We suggest this could be due to enhancing self-efficacy and helping participants activate relevant knowledge regarding effective strategies. While the increasing levels of goal commitment over time lends support to this suggestion (i.e., self-efficacy has been found to be positively associated with goal commitment: Locke and Latham, 2002), future research should be conducted to empirically validate this suggestion.

In Study 2, the early patterns (see Figure 3) for goal performance and commitment for the visualization condition show an interesting dip at time 2 (and generally starting somewhat lower than the other condition). We theorize that this could have been caused by the act of identifying barriers. Identifying barriers could highlight to people the challenges of reaching their goals. Previous research has found that goals that are perceived as highly complex and difficult can be demotivating, leading to poor performance (Locke and Latham, 2002). In our study, the dip in performance and commitment was short-lived, as participants recovered and ended up with stronger performance and commitment. Future research should empirically study self-efficacy beliefs over time, varying the degree of challenge presented in possible barriers to determine at what point identifying barriers impedes performance gains longer-term.

Although our results suggest visualization can help prevent the rebound effect, we suggest that future research continues to examine other influences on the rebound effect, such as value congruence and multiple goals. Long-term goal attainment can be affected by how important the goal is to the individual. Researchers suggest that the fit, or value congruence, which maps the individuals' goals against

their views of self (Burkley et al., 2015; Li et al., 2015), can help explain rebound effects and/or spillover effects (Unsworth et al., 2013). Future research should also explore the role of multiple goals, and whether individuals have goals that either conflict with the goals they set or reinforce these goals. Little is known about goal-directed behaviors with multiple goals (Bateman et al., 2002; Louro et al., 2007) and future research should help to shed light on how organizations can help individuals reach PEB goals, which typically are not the first-priority goals for employees (Lo et al., 2012). Examining the interaction of hedonic and gain goals on environmental goals, which are typically more normative, could also be a useful lens for future research. Environment goals for individuals in the workplace may have the challenge of creating few individual positive gains, leading to lower stability for normative goal activities.

Our research helps address calls for more Green IS studies at the employee level (e.g., Elliot, 2011; Wang et al., 2015). Although there is little research on interventions encouraging employee PEBs, research on citizens provides some important lessons for employee behaviours and ideas for future research. The meta-analysis examining ten interventions (Osbaldeston and Schott, 2012, pp. 272-273) demonstrated four interventions with the strongest effects: in addition to goal setting, prompts (“non-informational reminders that focused only on when to perform the next specific action”), social modeling (“passing of information via demonstration or discussion in which the initiators indicate that they personally engage in the behavior”), and cognitive dissonance (“accessed pre-existing beliefs or attitudes and attempted to make participants behave in ways that were consistent with those beliefs to reduce the dissonance”) are most effective. Future research needs to extend and test these other interventions in organizational contexts. However, as described earlier, organizational factors may alter the effects of any intervention, and understanding the interventions (and their combinations) that are most effective in organizations as well as the theoretical mechanisms behind them are needed.

Research on interventions helps enrich more traditional IS research. For instance, Melville’s (2010) belief-action-outcome framework assumes that changing beliefs will result in behavioral change. However, with sustainability research, we often assume the opposite direction for effects: if one can change individuals’ behaviors, then their beliefs will follow. This is because individuals start thinking about themselves in different ways after observing their own behaviors. In support of this, it has been demonstrated that information alone is not a strong predictor of PEBs (McKenzie-Mohr, 2000); rather, interventions are needed to influence them. Thus, we suggest that our IS frameworks be extended to consider feedback loops, in which beliefs are affected by behaviors.

We also suggest that future interventions should be developed using multiple approaches. Green IS research at the individual level generally takes a behavioral-science approach (as we did in these studies) or a solution-oriented (design science) approach (El Idrissi and Corbett, 2016). In the future, researchers should combine the two, for instance, by developing a system to help automate environmental interventions and the recording of computer-based sustainability outcomes. For instance, Orland et al. (2014) installed wireless plug-load sensors in employees’ offices to measure their appliance use and then provided a web-based game called ‘Energy Chickens’ to encourage them to save energy. Similarly, Simon et al. (2012) installed smart plugs and sensors in employees’ offices and provided them with a ‘Climate Race’ game to encourage energy reduction.

More generally, serious games and gamification hold promise for the future design of environmentally based systems in organizations (Bui et al., 2015; Liu, Santhanam, and Webster, in press). However, these systems need to be designed carefully for several reasons. First, gamified systems should not remain static but should keep the user intrinsically motivated over time. In contrast, Chen et al. (2012) created a digital aquarium that reflected energy use in group offices, measured through sensors. They found decreases in energy use in the beginning, but then rising energy use over time. They suggested that this could be due to ‘user fatigue’ with the aquarium, or users becoming used to the system. Instead, they could have helped maintain engagement through using progression elements such as quests, levels, progressive disclosure, or adjusting the levels of difficulty (Liu et al., in press). A second concern relates to privacy: because energy use in gamified systems is often tracked with sensors,

users can become concerned with who will see their data (Jahn et al., 2011). However, if users understand the individual benefits of electronic monitoring, they will be more likely to accept the system (Bolderdijk, Steg, and Postmes, 2012). A third consideration involves matching gamified elements with the intended goals for the system (Liu et al., in press). For example, the biking study described earlier found that those who accessed gamified rankings travelled different distances based on their goals: those accessing rankings with competition or climate protection goals travelled further than those accessing rankings with self-exploration goals, while those with collaboration and climate protection goals who accessed the CO₂ savings displays appear to have travelled the furthest (Ebermann and Brauer, 2016). Thus, more research is needed to determine how multiple goals should be linked to gamified elements (Ebermann and Brauer, 2016).

Turning to implications for practice, our findings could be used by organizations during PEB training sessions and to help them implement and encourage PEBs among their employees. Identifying barriers, strategies to overcome the barriers, and visualizing success could be added to these processes to promote longer-term effects and avoid rebound effects. When employees identify barriers, management could help them identify strategies and resources to address these barriers, as individual employees may not have control over resources needed to implement the desired strategies. Capturing and sharing this knowledge could enhance PEBs more generally within their workplaces.

In conclusion, this paper contributes to Green IS research in several ways: conceptually (by responding to calls for more theory-based research), methodologically (by measuring objective computer-based energy usage in study 1 and by utilizing a diary method in study 2), and practically (by demonstrating the effectiveness of visualization to goal setting). We encourage future research that adds to theory and practical understanding for organizations working to enhance pro-environmental activities in their workplaces.

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