Goal Conflict and User Experience: Moderators to the Use of the Clock Thermostat as a Device to Support Conservation Behavior

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ABSTRACT

Programming clock thermostat settings involves no financial cost to the consumer and requires little effort, making it a feasible target behavior for increasing energy efficiency through automatic control of temperature setbacks according to time of day and activities of the residents. Goal setting theory was previously used as a framework to experimentally test the energy saving effects of goal and information specificity and user experience on planning a programming strategy and the resulting projected energy use. Users who had never owned a clock thermostat projected significantly higher savings than users who already had a programmable thermostat. An experiment was designed to test whether conflict in comfort and conservation goals between household members moderated thermostat conservation behavior. Using only individuals who did not own a clock thermostat one group was asked to consider other household members. This group saved significantly less energy supporting the hypothesis that goal conflict between household members is a moderator of conservation behavior. Results are discussed in terms of implications for energy conservation programs to change thermostat behavior.

Introduction

The success or failure of household energy conservation programs is ultimately dependent on human behavior that can be difficult to change. It is therefore more likely that interventions that seek to make existing behaviors more efficient will have greater success than those that seek to change set behaviors (Weihl & Gladhart, 1990). Changing thermostat settings involves no financial cost to the user and requires little effort, making it an ideal target behavior for increasing energy efficiency (Turner & Gruber, 1990). In addition, the programmable thermostat can help increase energy efficiency through automatic control of temperature setbacks according to time of day and activities of the residents (Darley, 1978).

Unfortunately, the programmable thermostat has not lived up to its potential as a conservation device (see Pigg & Nevius, 2002). According to a report by the EPA (Energy Star, 2004), the 10 to 30% projected energy savings of such a thermostat remains untapped due to users' reluctance to use their own, or default, programs and consequently operating the thermostat manually. Energy Star also suggests that users who do use their own programs might not set temperatures to be any more conservative than if they were using a manual thermostat. Thus, despite a potential to help users save energy, the programmable thermostat is often not used any differently than the manual version.

The comments of Energy Star (2004) illuminate the two potential stages where users can save energy with the programmable thermostat. The first stage is in the programming and the second is in the daily use of the thermostat. If users program the thermostat with low settings for nighttime and for when they are out of the house, the thermostat will automatically warm the home to the desired temperature prior to waking or returning to the house, both saving energy

and maintaining comfort. A previous study by McCalley and Midden (2003) investigated human behavior in relation to each of these two phases using goal-setting theory (Locke & Latham, 1990) as a framework. This theoretical framework has been previously used to successfully predict the effects of motivation on human behavior in several other disciplines such as work and educational psychology, as well as environmental and conservation psychology (McCalley & Midden, 2002, McCalley, 2004). The present study is the second in a research program designed to reveal fundamental psychological responses that control human interaction with the programmable thermostat in an effort to support energy conservation. Through the understanding of basic human responses that affect conservation behavior it is expected that conservation efforts will become more successful whether they are based on information programs or technological improvements, as in the present case.

Goal Setting Theory

According to goal setting theory, setting a goal can have 1) an indirect effect on the form of strategy development, and 2) a direct effect through effort, persistence and directed attention (e.g. Locke et al., 1981; Earley, Wojnaroski & Prest, 1987). The direct effect arises from the motivation of the individual causing them to focus effort on the performance of the task. The indirect effect is cognitive and improves the strategy or plan that an individual makes in order to use this focused effort. Locke et al. (1981) found that assigning a goal increased the quality of plans that individuals made in order to reach their goals.

Earley et al. (1987) also proposed that goal setting and task-relevant information affect *performance* by influencing the individual's effort expenditure and planning. Earley et al. (1987) also stressed the importance of making both the goal and task information very specific. They proposed that a goal to attain a specific level of performance (for example, “increase production by 15%”) gives more information in the form of what is expected of the individual than a non-specific (e.g. 'do your best') goal. Specificity should also focus attention on the task and stimulate the development of task-relevant plans where the individual decides how to achieve the assigned performance level and how to allocate personal resources to the task. This, in turn, should result in the individual expending more effort to attain the goal and thereby increase performance. A general, or non-specific, goal would therefore result in a lower level of task performance than a specific goal (Earley et al., 1987). Additionally, highly specific information on how to achieve a goal (e.g. “Lowering the temperature one degree during a 6 hour period will save 136 cubic meters of gas per year in a home the size of yours.”) will help the user form a good strategy to save energy leading to better conservation performance. Non-specific information (e.g. “lower temperatures save energy”), like a non-specific goal, will not improve performance.

In the case of the programmable thermostat, it was expected that a more specific goal than, “ do your best” (i.e. “lower your energy use by 10%”), and very specific information on how the goal could be achieved would directly influence the energy use strategy of the user when preparing to program the thermostat for daily use. In accordance with goal setting theory, it would also be expected that performance, in turn, would be increased (i.e. the planned strategy would reflect the user’s goal to lower energy use by 10%).

Goal Setting and the Programmable Thermostat

In an effort to understand the fundamental human psychology determining the success or failure of the programmable thermostat as an instrument of household energy conservation a research program was designed to systematically examine the relationship of individual motivation to the application problem of the programmable, or clock, thermostat.

Recent investigations into integrating energy feedback into individual appliances (e.g. the washing machine) indicate that having the user set an energy saving goal can specifically motivate conservation behavior (McCalley, 2000; McCalley & Midden, 2002). In the case of the programmable thermostat, it was expected that the level of specificity of both the goal and the information would directly influence the energy use strategy of the user when preparing to program the thermostat for daily use and, in turn, affect performance.

An experiment designed to test these assumptions found that the time to plan a strategy was indeed affected, but the effects did not carry over to influence conservation behavior in the programming of the thermostat. In other words, as predicted by goal setting theory, subjects with a specific goal, and specific information on how to reach that goal, spent a lot of time planning what one would presume would be a good conservation strategy. However, when the subjects were given the opportunity to program a thermostat according to how they would do it if it were in their own home, no overall energy savings were found. Thus, despite specific goals and information and apparent effort in making a good conservation plan, overall energy saving performance was not affected.

Interestingly, one variable did have a significant effect on performance. This variable was whether or not the subject had had *prior experience* with a clock thermostat. It was therefore speculated that subjects who had never before programmed such a thermostat had perhaps overestimated their present household temperature setting resulting in a bigger difference in ultimate energy savings. However, statistical analysis revealed no significant difference between the mean at-home temperature of the inexperienced and the experienced users. A further analysis of the effect of experience on the level of the goal chosen (whether it was 0, 5, 10, 15 or 20%) in the specific goal conditions revealed no significant difference between the groups. Furthermore, nonparametric tests of subjects' rating of the importance (on a scale of one to five) of three items (energy, money, and comfort) revealed no significant difference between the two groups. Thus, both groups appeared to be similar in their priorities and to behave in much the same manner with the exception that the group that had never before used a programmable thermostat projected a greater savings of energy.

Experience Versus Inexperience

An analysis of the goal level set by experienced and inexperienced users revealed that specific information led to higher goals being set by both groups. A lack of significant effects of information and goal on performance indicated that planning time did not predict performance. Goal setting has been found to enhance performance in many previous studies, however, the fact that inexperienced subjects saved significantly more energy than experienced subjects implied that experience somehow cancelled out performance in this particular instance. It was therefore speculated that the experienced group might have found that their home programmable thermostats do not save a noticeable amount of money or energy and are thus simply a convenient way to control household temperature. Inexperienced users could have had higher

expectations of the savings that a programmable thermostat would provide or they might not be as resistant to change or see the thermostat as a conservation device rather than just a convenience.

A recent survey by McCalley (2003) lent support to the assumption that experienced and inexperienced could have different expectations of a programmable thermostat. The survey found that more than eighty-six percent of household members living in homes with programmable thermostats said that they, or other family members, overrode the thermostat program at least once a day. This indicated that household members are often at odds with each other as concerns thermal comfort. It was therefore hypothesized that the most likely reason for persons who are inexperienced in using a programmable thermostat to project greater savings than persons who own and use one is that they had not yet experienced discouraging results of an anticipated savings that was thwarted by other household members.

The user must be both motivated and have the knowledge to plan a program strategy that provides a balance of comfort, health, economic and conservation considerations for the *whole household*. Proceeding with the assumption that motivation and information were adequate in the earlier study, an experiment was designed to test whether inexperienced individuals could be manipulated to behave in a manner similar to the experienced subjects in the earlier experiment by creating goal conflict. It was hypothesized that those individuals experienced in programming a clock thermostat had experienced a conflict between their own goal to save energy and what they perceived as the goal(s) of others in their household (presumably optimal thermal comfort). An example of this is when a parent programs the thermostat to be one degree lower than previously in order to save energy and a teenager, sitting still behind a computer for hours, becomes chilled through lack of movement and overrides the thermostat program with one push of a button. According to the McCalley (2003) survey, this is a frequent scenario.

The experiment was thus designed to prompt the expectation of conflict with other household members in inexperienced users. The level of information specificity was also thought to be a possible factor as highly specific information on how the thermostat could be set to save energy by lowering temperatures would be more likely to activate cognitive effort which would in turn make conflict more salient.

Experiment

All subjects were inexperienced in the use of a programmable thermostat and all were asked to set an energy conservation goal. Thus, in contrast to the former study, goal and experience were held constant and only information specificity and the new independent variable of discouragement were manipulated. It was expected that the chosen goal levels of subjects in the current experiment would not be different between groups and would be similar in range to those chosen by the inexperienced subjects in the earlier study.

Design

A 2 x 2 (Information/ specific or non-specific x Discouragement/ yes or no) factorial design was used. Information was manipulated so that a subject either received specific information about how to save energy on the task (high specificity) or general information (low specificity). All subjects were asked to try to save 15% energy over their current use using the information given. The discouragement manipulation was a reminder to consider others who

share the dwelling when making a new thermostat program as previous research has shown that most household members will override the program settings at least once a day. The dependent variable was the projected percent of change of energy use calculated from the current temperatures used by the subjects and the temperatures programmed into a simulated programmable thermostat after the third and last programming that occurred after the discouragement treatment.

Subjects

Subjects were 100 students and office workers of the Technical University Eindhoven, The Netherlands, and lived in their own rented or owned apartments or homes that they shared with family or fellow students. All subjects were inexperienced at using a programmable thermostat, but were familiar with, and set their own, simple thermostat at home.

Procedure

A computer-simulated thermostat was introduced to all subjects as a new design for a programmable thermostat that enables people to save energy by remembering for them when to turn the temperature up or down. Computers that automatically randomly assigned one of the four experimental conditions to the subjects ran the experiment. Subjects were asked to fill in a schedule with the temperatures that they set at home for various periods of the day corresponding to those for the programmable thermostat. The four conditions consisted of the combinations of low and high specificity of information regarding how an individual could save more household energy and a discouraging message or none as described above. In the low specificity information condition subjects were given some general information about thermostats and simply told that lower temperatures save energy. In the high specificity condition, subjects were given information about the exact amounts of energy that could be saved for various types of houses for each degree of temperature lowered for a specific amount of time. This information was presented in a manner that could be easily used by the subject to calculate a specific savings goal if they so desired. After reading the text, subjects were either asked to set a goal for themselves to save 0, 5, 10, 15, or 20 percent (high specificity) or simply asked to do their best to save energy (low specificity). Next, the screen showed the simulated "new" thermostat that subjects then programmed according to the instructions given. Subjects were asked to repeat this process once more after being given either a short neutral message or the discouragement treatment reminding them to consider others in the household.

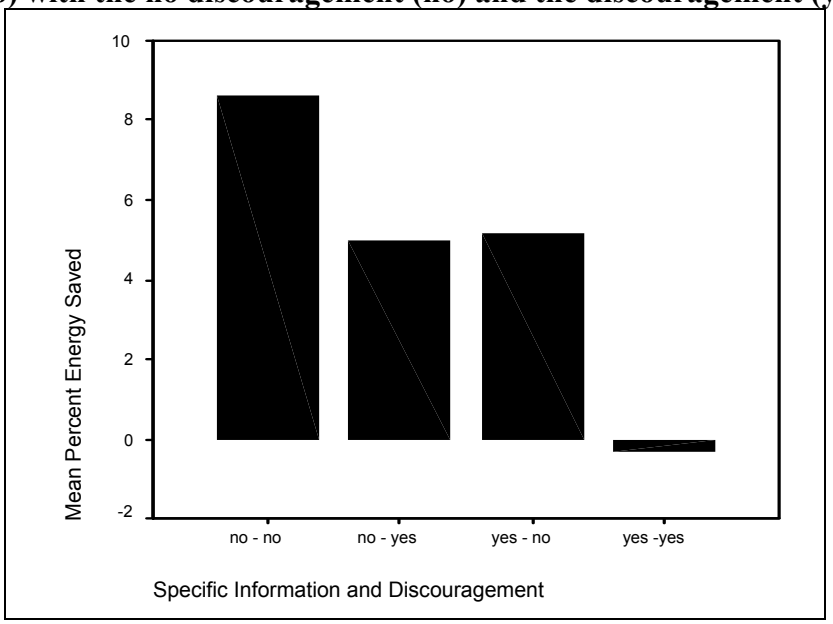
Results

General Linear Model (GLM)[1] revealed a highly significant difference between conditions of high and low information specificity and whether or not the subject was reminded that other household members must be considered when the thermostat is programmed ($F = 4.87$, $p =. 004$). A post hoc analysis using LSD revealed that the group that was first given highly

[1] The GLM, or General Linear Model is a multivariate procedure that provides regression analysis and analysis of variance for multiple dependent variables and one or more factor variables. In the case of the present study, the procedure was used for analysis of variance between two factor variables and two dependent variables.

specific information on how to save energy by lowering temperature settings and later received a reminder to consider other household members was significantly different from the other three treatment groups (Figure 1.). This group not only did not save energy, but also actually anticipated using slightly more energy than before.

Figure 1. Bars represent combinations of specific information (yes) and non-specific information (no) with the no discouragement (no) and the discouragement (yes) treatments.



Subject groups were also compared as to the range of goal levels set and were found similar in their range and level of goal choices as expected with no significant differences between the treatment groups (Table 1.)

Table 1. Goal levels represent the percent (%) of savings that each subject chose as a conservation goal for household energy use. Groups are defined by whether or not they received the specific information (yes or no) and by whether or not they received the discouragement treatment (yes or no).

		GOAL					Total
		,00	5,00	10,00	15,00	20,00	
Groups	nn		4	13	1	1	19
	ny		7	8	4	1	20
	yn	2	2	8	5	2	19
	yy	1	5	9	3	1	19
Total		3	18	38	13	5	77

Discussion and Conclusions

As predicted, all groups behaved similarly as to the level and range of goals selected as inexperienced subjects had done in the previous study descried earlier. The results supported the hypothesis that when subjects were prompted to consider other household members they would project a significantly lower energy savings than subjects who received no such prompt. It was found that the difference was significantly stronger in the group that had received highly specific information. Thus, the hypothesis that the level of information was a moderator to goal response was supported. It, at first, might seem counterintuitive that receiving more specific information on how to reach a conservation goal should in fact initiate a negative response in the sense of conservation, but as Earley et al. (1983) had stated, specific information will increase strategy planning. The assumption can be made then that the more effort an individual has placed in the planning of an energy conservation plan, the realization that the plan is likely to go awry due to the conflicting goals of others is more likely to enhance the discouragement factor. It can also be speculated that increased planning demands more cognitive effort and that the activation of increased cognitive resources has made the anticipated potential of conflict more salient.

Another way to view the conflict process is to assume that the initial goal chosen by the subject holds priority. However, when the attainment of the activated goal is threatened, as in the discouragement treatment, then a sub goal assumes higher priority (Austin & Vancouver, 1996). For example, in the present study, the sub goal might be to please others and this takes over when the goal to save energy is threatened. Thus switching to a sub goal negates the goal conflict of the subject.

In practical terms, the clock thermostat has the potential to be a valuable support to energy conservation behavior. The benefit of the clock thermostat is that it is automatic and therefore "remembers" for the user and also can be set so as to activate the heating system before household members get up in the morning or return to the home, thus warming the house and providing more thermal comfort to the residents. A simple nightly setback of temperature for eight hours (based on an average modern Dutch house) will save ten percent of the cost of heating over a year. An average lowering of household temperature of one degree C would result in a savings of 13 percent per year and lowing the temperature three degrees C would enforce a savings of 36 percent (Wartenbergh, 2003). Unfortunately, we know that individuals who already have such a thermostat do not often use it as an energy conservation device. What has now been established is that potential new users have a higher expectation of the resources that the programmable thermostat provides (Warenbergh, 2003) and thus it might be possible to reinforce this expectation by early intervention when a programmable thermostat is first purchased.

Intuitively, it would seem a practical matter to include packaging information that tells new buyers how to save energy through the programming of the thermostat but the research has shown that this is likely to fail as soon as the user experiences conflict with other household members regarding temperature settings. One potential means to prevent this undesired effect is to integrate the information as well as a goal setting option and feedback into the thermostat in a manner that will address all household members as it is known that negative reactions to the temperature setting are dealt with by household members overriding the set program on a frequent basis (McCalley, 2003). Thus, other household members are in contact with the device and might respond to product-integrated feedback in a manner that encourages them to agree with the goal of the person who has set the program. In this way conflict might be avoided.

It is also important to note that little, or no, research has addressed inter- and intra-individual goal conflict with regards to energy conservation. It is only logical to assume that negotiations regarding household conservation measures such at setting temperatures lower, using less hot water, and turning off light, among others, must occur. To date, virtually nothing is known about how household conservation decisions are negotiated and it is therefore recommended that further research address this important question.

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