From motivation and cognition theories to everyday applications and back again: the case of product-integrated information and feedback

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Abstract
Various moderators of the relationship of goal setting and feedback are explored in four examples of applied empirical research. A selection of theoretical frameworks borrowed from varied disciplines guided the studies and are discussed in terms of their value to the particular questions investigated. The experiments all entailed the use of product-integrated energy feedback and illustrate a progressive understanding of how goals, feedback and other information provided to the user can generate or support better energy conservation. Experiment 1 exemplifies the successful use of combining goal setting and feedback and provides a basic understanding of the interaction from the perspectives of goal setting theory and Feedback Intervention Theory (FIT). Experiment 2 compares FIT to another, fundamentally different, cognitive framework, and the minimal justification principle. The study gives insight into how goals and feedback work through attention focus and the goal hierarchy to guide behaviour, the role of attitude in this process, and offers evidence that FIT better accounts for task specific conservation behaviour. Experiment 3 addresses the role of goals and information in strategy planning through the perspective of goal setting theory. Results of this study suggest the need for more development of the basic theory and illustrate the strong motivational properties of having a goal. Experiment 4 investigates a more fundamental process, anchoring bias, taken from decision theory and the theory of rational choice. This experiment was based again on FIT and provided further evidence of behavioural control through the focus of attention at a particular level of the goal hierarchy.

Introduction
The use of established motivation and cognition theories to guide applied research offers greater efficiency of study resources by helping to avoid the research equivalent of a "wild goose chase" while concurrently contributing to the broadening scope and refinement of the theories themselves. The copious energy feedback studies of the late 1970's and early 1980's stand as an example of how a general lack of theory sustained a flow of research which often produced contradictory results. Despite review articles, such as that of Dwyer et al. (1993), that pointed out the often effective influence of goal setting on conservation behaviour, a theoretical basis for the results remained lacking. It was only after a long established theoretical framework based on motivation, and which recognizes the link between human goal setting and performance feedback, was borrowed from organizational psychology were positive feedback results consistently replicated (McCalley & Midden, 2002). The present paper discusses the interaction of goal setting and task information as a moderator of conservation behaviour and illustrates how various theories can guide applied technology research in the area of energy conservation. Summaries of empirical results from a sample of four experiments using various types of product-integrated information are explained in relation to their guiding theoretical frameworks. The frameworks addressed include goal-setting the-

ory (Locke & Latham, 2002), social- cognitive theory (Bandura, 1991, 1997; Wood & Bandura, 1999), minimal justification (Aronson, 1966; Katzev & Johnson, 1983), anchoring bias (Tversky & Kahneman, 1974) and feedback intervention theory ("FIT", Kluger & DeNisi, 1996). The purpose of this discussion is to show how these theories, traditionally associated with other fields, can be used to both further energy conservation and contribute to the development of the theories themselves.

The past decade has seen a significant improvement in the advancement of energy efficiency in the household and it is estimated that the use of the best currently available technology could reduce present energy consumption by 30% (Bertoldi, et al., 2000). Although exact figures are difficult to estimate, it is speculated that a further 10% can be saved by changing wasteful household behaviours through the use of motivation techniques and feedback information to the consumer (Darby, 2000). Unfortunately, and however true this estimate might be, the idea is not new and a copious amount of past research has not brought forth the hoped for "magic formula" of techniques to curb unnecessary household energy use.

Several forms of interventions to promote household energy conservation have been tested but research previously focused primarily on energy consumption feedback (Shippee, 1980). It had long been thought that by allowing users to see how much energy they are using in a frequent and timely manner would encourage them to curb waste. However, results of feedback studies remained mixed until it was recognized that, at least in certain conditions, response to feedback depended on whether or not users had a specific energy conservation goal (McCalley & Midden, 2002). Nonetheless, many questions remain as to the nature of the goal-feedback relationship and the contextual effects of various moderators.

EXAMPLE 1: GOAL SETTING

The first example describes an experiment designed to examine the role of goal setting and its effect on feedback response. In this case two closely related theories were combined. The first was goal setting theory that was developed by industrial-organizational psychologists Locke and Latham (see Locke & Latham, 2002, for a review) to study the relationship between task performance goals and the performance level achieved within work settings. Goal setting theory identifies four mechanisms by which goals affect performance. These mechanisms 1) direct attention and effort to goal-related activities, 2) energize the individual both mentally and physically (e.g. higher goals create more effort than lower goals), 3) prolong the effort to reach a goal, and 4) arouse, lead to discovery of, or retrieve task-relevant knowledge and strategies (Locke & Latham, 2002). Further, the theory states that a goal can only be (effectively) reached if appropriate feedback is given so that the individual knows where they stand in relation to their objective (e.g. goal). The second theory, Feedback Intervention Theory (FIT) is still in a developmental stage and focuses on feedback as the primary moderator of goal achievement. FIT is designed to be specific to individual task performance in contrast to the more general and broader applications of goal setting theory in industrial and organizational settings. FIT is based on the assumption that goals are organized in a vertical hierarchy from lower task learning goals to higher self-related goals (e.g. "I want to be a conservationist.") and that feedback is the mechanism that directs attention to a specific goal level. Thus task performance is the result of feedback directing attention to a task related goal and thereby activating it. If inappropriate feedback is given that directs attention to a higher goal such as to thoughts of the self rather than the task, a performance decrement results. FIT is compatible with goal setting theory and can be seen as a sort of subtheory appropriate to individual task applications that allows for a more specific interpretation of the experimental data.

The example experiment used a computer simulation of a washing machine control panel and required subjects to provide washing program settings according to varied washing scenarios (e.g. "wash a load of very soiled jeans".) The control panel was based on an existing state-of-the-art washing machine. The simulated version was discretely modified to include a kWh energy meter, while providing all the basic prerequisites for good feedback (see Midden et al., 1983) with the improvements that feedback was given instantly and was specific to only one source of use (the washing machine) and to each washing program choice. Included was an explanation of the experimental procedure and a brief questionnaire regarding household membership and washing practices. A series of pilot experiments had revealed monetary (McCalley, 1999) or energy (McCalley, 2000) feedback was not enough to generate conservation behaviour even when feedback was immediate and specific. The experiment was presented to subjects as being a test of a variety of possible new convenience features for electronic control panels or interfaces and subjects remained unaware of the true nature of the experiment until it was completed.

Subjects were 120 local residents recruited randomly from the telephone book and randomly assigned to one of four experimental conditions. The experiment was conducted using a using a no-feedback-no-goal group as control and three feedback groups (no goal, self-set goal, assigned goal) for comparison. Thus, two groups of subjects were either asked to set a conservation goal to reduce energy use while washing and were given a choice of goal levels of either 0, 5, 10, 15, or 20 percent or assigned a 20 percent savings goal. In accordance with goal setting theory the goal was expected to motivate the individual to save energy and, in accordance with FIT, the feedback was task-specific in order to direct attention to the task level.

Results of the experiment suggested that by integrating immediate energy feedback into household appliance interfaces significant amounts of energy could be saved, but only if the subject had first set a conservation goal (Fig. 1). Thus, generating conservation behaviour on the part of the consumer required a prior commitment in the form of setting a specific energy saving goal before the feedback information produced significant savings (McCalley & Midden, 2002).

Prior to this experiment many other studies over the course of several years had tried feedback alone to attempt to generate energy savings with mixed success. Some had also used a goal but with no theoretical framework to guide the research valid conclusions regarding the combination of goal and feedback were lacking. The use of goal setting theory in the example case allowed for a confirmation of the

generalizability of the theory to at least one energy conservation application and additionally broadened the application of the theory. FIT allowed the more focused theoretical interpretation that, by giving energy feedback related to each wash, attention remained focused on the task. Nonetheless, researchers who believe that positive attitudes towards conservation are the determining factor in energy saving behaviour could challenge this interpretation by claiming that the experiment itself had positively biased subjects to have a more conservationist attitude. In order to meet this challenge, and prove that attention focus was the determining factor, another experiment was designed and serves as the following example.

EXAMPLE 2: MINIMAL JUSTIFICATION AND FEEDBACK INTERVENTION THEORY (FIT)

This experiment was designed to test the FIT interpretation of prior results by comparing it to another cognitive motivation theory. As described above, the FIT (Kluger & DeNisi, 1996) interpretation attributes successful conservation behaviour to goal setting as a means of focusing attention on the washing task, thereby making the energy feedback more salient while the feedback itself helps activate and maintain the task related goal. However, much research has investigated the role of attitude in the explanation of conservation behaviour. Again originating from organizational psychology, social cognitive theory (Bandura, 1991) explains changes in behaviour as a triadic interaction of behaviour, environmental events and the cognitive and other personal factors of the individual. Behavioural changes are seen as responses to attitude change where the individual has incorporated a personal view which directs behaviour through a sense of mastery and control that the individual attributes to the self rather than an outside influence. According to this view behavioural change might have come about in the first experiment through an attitude change triggered by the request to subjects to fill out a short questionnaire before beginning the washing tasks. The way this works is that an individual who is asked to comply first with a small request is later more likely to comply with a larger, more difficult (and generally related) target request (Freedman & Fraser, 1966). This is called the "foot-in-the-door" technique that is well known in marketing research and is based on a social psychological formulation of the minimal justification principle (see Katzev & Johnson, 1983). If filling out the questionnaire was the first request, then the target request was asking subjects to comply with setting and reaching an energy savings goal. In this interpretation the energy feedback simply served as a means (information) to the end (save energy).

Using the same tasks and subject (N = 120) selection and assignment as in the first experiment, the second experiment had four conditions, all with feedback. The design was thus a 2 (goal/no goal) x 2 (foot-in-the-door/none) factorial. Subjects in the goal conditions were asked to set a goal from the same range as the first experiment. In order to make sure that a foot-in-the-door manipulation took effect a second small request to answer an additional short household energy questionnaire in the near future was added to the original questionnaire request. Multiple requests have been found to increase the effects of compliance (Dillard, 1991; Gorassini & Olson, 1995). Increasing sequential requests (otherwise termed the 'multiple request strategy') reinforces the compliance effect by changing the self-perception of the individual to be positive in the direction of the request.

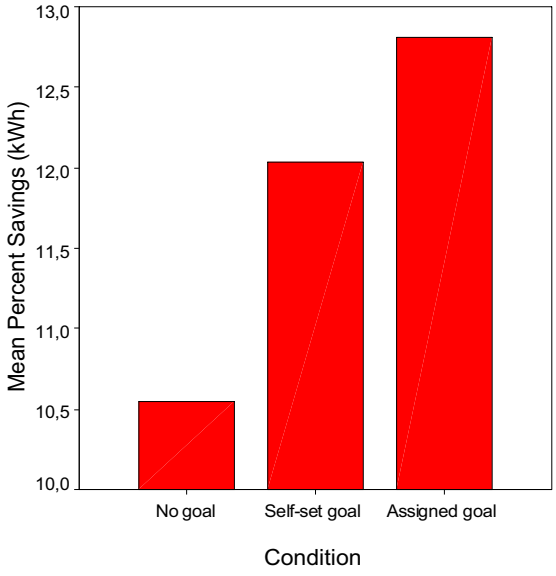

Figure 1.

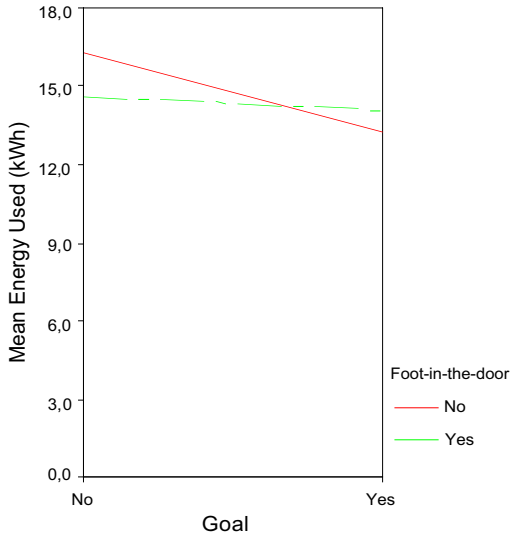

Figure 2. *Lines represent the 2 experimental groups, one of which received the foot-in-the-door treatment ("Yes") and the other did not ("No").*

If the result was an increase in energy savings in both foot-in-the-door conditions the view that conservation behaviour is a response to a change in attitude or self-perception (e.g. Burger, 1999; DeJong, 1979) would be supported. On the other hand, FIT predicts that any manipulation which directs attention to the self will attenuate effects of feedback and thus predicts that the addition of a compliance request (foot-in-the-door) will nullify the effect of goal setting in the combined goal setting and foot-in-the-door condition. Additionally, it was predicted that the foot-in-the-door treatment

would have an effect on attitude that would be indicated by an increase in the amount of the goal set by subjects receiving the foot-in-the-door treatment.

GLM (General Linear Model) analysis revealed a highly significant main effect of goal setting but there was no significant main effect of the foot-in-the-door treatment (Fig. 3). There was, however, a significant two-way interaction between minimal justification and goal setting where subjects in the goal setting condition *did not save as much energy* if they had first received the foot-in-the-door treatment in contrast to the group receiving no minimal justification treatment. A chi-square test for the dependent variable of level of goal set (0, 5, 10, 15, or 20 percent energy saving goal) within the goal setting condition revealed a significant effect of minimal justification. Thus goal setting increased conservation behaviour unless an attitude change occurred via the foot-in-the-door treatment in which case the minimal justification manipulation inhibited *response to the goal*.

In terms of FIT, the outcome can be interpreted as evidence that the minimal justification treatment directed attention to a meta-task level (self) and away from the task performance level thereby attenuating the effects of the feedback. Additional proof for this interpretation lays in the fact that S's set higher goals when they received the foot-in-the-door treatment. This is in accordance with a self-perception interpretation that S's were thinking at the meta-level of attitudes regarding the self and not directing attention to the specific task. Thus, the foot-in-the-door group evidently thought of themselves as conservers and set high conservation goals accordingly but were distracted from the conservation goal by paying more attention to a super ordinate self focused goal. In other words, this group became distracted with thoughts of themselves rather than the task at hand.

EXAMPLE 3: GOAL AND FEEDBACK SPECIFICITY

Example 3 tested strategy development, or planning, which relates to the fourth mechanism described in goal setting theory and which had not been previously tested in the context of product-integrated feedback. In the first two example experiments (see also McCalley & Midden, 2002) the feedback and goal relationship was tested only at the direct influence level as described by Earley et al. (1987). The third experiment tested the effects of the specificity level of both goal and information on planning strategy and task performance.

Specificity focuses attention on the task and stimulates the development of task-relevant plans where the individual decides how to achieve the assigned performance level and how to allocate personal resources in doing the task. This, in turn, results in the individual expending more personal effort to attain the goal and increasing performance. It is thought that an individual with a general goal does not have a specific performance level about which to think, and therefore spends less time thinking about how to work on the task. A general or non-specific, goal would therefore result in a lower level of task performance than a specific goal (Earley et al., 1987). Specificity denotes the detail level of the goal where the term specific goal refers to a goal to conserve a particular amount energy and a nonspecific (e.g. general or vague) goal refers to the condition where subjects are asked to simply do their best in performing a task. The product used in the study was a simulated prototype programmable thermostat.

The experiment addressed the fundamental question of whether information given prior to performing a task has the same, or similar, effect as setting a goal. Both goal setting and giving detailed information are thought to affect strategy development, as measured by planning time. It was thus hypothesized that planning time and energy savings would be greater for individuals given a specific goal or detailed task knowledge than for those having a vague goal or little task knowledge. Furthermore, as goals provide both motivation and a form of information to the user it was hypothesized that having a specific goal, as well as specific information, would enhance both strategy development and performance.

A 2 x 2 x 2 (Goal x Information x Experience) crossed factorial design was used. Subjects were 120 local residents recruited partially from a random selection of local telephone numbers and partially from university personnel unfamiliar with the research program who were then randomly assigned to one of four experimental conditions. The goal manipulation consisted of a subject either choosing a self-set energy conservation goal, or instructed to "do your best" to save energy. 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). Experience (whether or not the subject owned and used a programmable thermostat) served as a third categorical control variable.

The computerized experiment proceeded by asking subjects to fill in the temperatures that they presently had programmed at home for various periods of the day. Subjects who did not have programmable thermostats (inexperienced) were asked to fill in the same schedule with the temperatures that they set for corresponding periods of the day on their home thermostats. After this, the computer randomly assigned subjects to one of four conditions. The four conditions were combinations of low and high specificity of information regarding how an individual could save more household energy and low and high specificity of an energy saving goal. 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. The text of both the high and low specificity conditions was designed to be approximately the same length. 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).

Subjects were then asked to open an envelope next to the computer and use a printed copy of a seven-day schedule to plan their program, and pencil it in, for the new thermostat. They were asked to push the enter key to continue the computer experiment only after they had made their plan. In ac-

tuality, a timer began as soon as they had pushed the enter button to more forward from the goal request screen and the timer stopped when they pushed the enter key after making their plan, allowing a measure of planning time to be recorded by the computer. After pressing the enter key, the screen showed the simulated "new" thermostat which they then programmed according to the instructions given and using their own plan.

Two dependent variable measures were taken. The first was planning time measured in minutes, as described above. The second was the difference between the actual total amount of current home energy use (cubic meters gas) per week based upon temperature settings, hours of use, etc. as reported by each subject and the projected energy use for a week based on the new settings of the simulated thermostat. As predicted, specific information increased planning time overall (Fig. 3). More interesting, however, was an interaction between information level and goal setting. When subjects set a specific goal for themselves, specific information increased planning time significantly, indicating that subjects were motivated to use information to optimize their chance of reaching their goal. In contrast, planning time was dramatically reduced as compared to all other conditions when subjects set a goal for themselves but had no specific information to help them achieve the goal. It appears that the motivating effects of goal setting overrode any careful consideration of the limited information subjects in the non-specific information condition had and caused them to jump to the task with little or no strategy preparation. In other words, a specific goal serves as a form of information that overrides planning, when specific task information is inadequate, through it's own decision making or motivational properties. Highly specific information served as a moderator of goal setting by shifting the goal setting effect from direct (motivational) to indirect (cognitive) according to goal setting theory.

As there were no significant effects of information and goal level on performance (energy saved) it is apparent that planning time does not predict conservation 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 implies that experience somehow cancels out performance in this particular circumstance.

In terms of goal setting theory the results of this experiment, as well as those of Earley (1987), suggest that the fourth mechanism described by Locke and Latham (2001) is not as straightforward as stated. Our findings suggest that the direct motivational properties of setting a goal are far stronger than the indirect properties and that further theory development should take place in order to gain a better insight into the factors underlying the fourth mechanism of goal setting.

EXAMPLE 4: ANCHORING BIAS

The final example illustrates the use of a technique that taps into a very basic human cognitive process described by decision making theory and the theory of rational choice (see Tversky & Kahneman, 1981). Decision making theory is designed to investigate those processes by which humans make choices. Most of those choices are rational but they

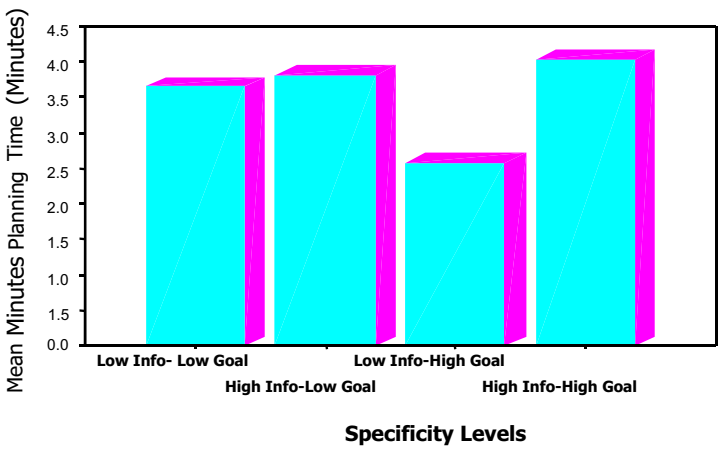

Figure 3.

can be influenced by how acts, contingencies, or outcomes are framed. Anchoring bias is the term used for the phenomenon of influencing numerical judgments through framing. In psychological terms, the anchoring effect can be defined as, "a biased estimate toward an arbitrary value considered by judges before making a numerical estimate" (Strack & Mussweiler, 1997). One of the best-known examples came from a study by Tversky and Kahneman (1974) where subjects were first presented with a number between 0 and 100 then asked to estimate whether the percentage of African nations in the United Nations was higher or lower than the number. Subjects presented with higher numbers gave high estimates and those presented with lower numbers gave low estimates. The study clearly showed that giving an arbitrary number to a person before they make a numerical decision biases their answer in the direction of that number (see also, Wilson, Houston, Etling, & Brekke, 1996).

Anchoring has been demonstrated to moderate self-selected goal level in a study of individual task performance (Hinsz et al., 1997) and thus implicates itself as a potential player in the field of goal-feedback interaction in conservation behaviour. In many circumstances a consumer chooses various levels of temperature such as for household heating, cooling (air conditioning), tap water settings, and automatic clothes washing and drying. All of these temperature choices greatly influence the amount of household energy used, and often wasted.

The effect of anchoring bias on temperature setting choice (thus energy use) was tested using two groups of 50 subjects each recruited from local adult residents and students from other departments of the university and who were unfamiliar with the research. One group did washes using the previously described simulated washing machine control panel that displayed the normal default temperature settings as programmed by the manufacturer into the real washing machine. In the experimental condition the machine defaults were all set to zero. Thus, for example, when a person chose the white/colored normal wash program the machine automatically sets the washing temperature to 95° C. The user must then lower the temperature to the desired setting if it is other than the default setting. This remained the case for the comparison group. In the case of the

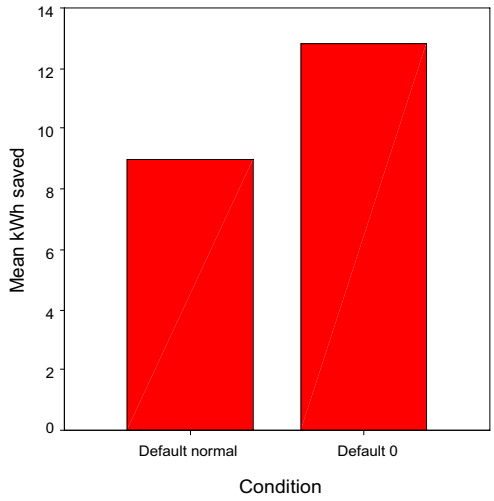

Figure 4.

experimental group, where all settings were set to zero, the subjects had to raise the settings to the desired temperature if they felt the cold water setting was undesirable. A social orientation (proself or prosocial) score was also taken for this group as social orientation has been found to influence conservation behaviour although it was assumed that with lower level cognitive functions social orientation would have no effect. This was also a test of decision making theory in that if an effect of social orientation was found then it would challenge the assumption that anchoring bias was acting on a lower (subconscious) cognitive level as believed by some researchers in the field of decision making.

The dependent variable was the total amount of energy used over the 20 washing trials. The group receiving only the high default temperature settings used an average of .89 kWh per wash in comparison with the group receiving the zero default settings that averaged .68 kWh per wash.

This represents a significant 24 percent savings by the low temperature default group. Social orientation was not found to be significant which supported the prevailing view that anchoring information is at some (albeit low) level consciously processed. FIT would support the assumption that anchoring bias acts at a task learning (low) level where subjects might perceive the low temperature setting as information from the manufacturer that higher temperatures are not necessary for a clean wash. According to FIT, the use of anchoring would not interfere with goal setting and feedback as it functions below the task performance level on the goal hierarchy, however, this has yet to be tested.

SUMMARY

Four examples of applied product research have been presented. In the first, the use of goal setting theory has offered a solution to the problem of why previous research using feedback to change wasteful energy behaviour has yielded such mixed results while confirming the intuitive realization that feedback can be an effective conservation tool. FIT has, in turn, provided an explanation for the function of goals and feedback in the illustrated applications allowing generalizability to other applications and a better understanding of both the applications of feedback and the role of attitude in the motivation to conserve as illustrated in the second example. By showing that a change in conservation attitude can be activated, as shown by the higher energy saving goals set by subjects subjected to a compliance manipulation, is important to conservation research. However, the example shown also illustrates that attitude and task performance can be at odds in situations where attention to task performance goals and feedback is critical and is subject to distraction by more global thoughts of the individuals' self-perception.

The third example tested one mechanism of goal setting theory, strategy planning, and found that effort spent in strategy planning did not directly translate to task performance. This contributes to the theory in that it demands a better explanation of how knowledge and strategy planning might or might not influence motivation in order to allow more generalizability. The study also contributes to energy conservation research in that policy makers often rely on information programs on the assumption that giving consumers more and detailed information will automatically lead to household energy conservation and because they are relatively inexpensive. The thermostat experiment, however, suggests that the relationship of information (knowledge), strategy planning, and the actual saving of energy is more complex than assumed. Given this, and the fact that information campaigns are often not as successful as projected (Winett & Ester, 1983; Winett & Neale, 1979), it is possible that funding research to understand the basic psychological processes which can support or create consumer conservation behaviour would be more cost effective. Furthermore, advanced technology, such as microprocessor controlled household appliances, and a broadening of potential information exchange exemplified by mobile telephones with SMS, internet and video, remain virtually unexplored as to their potential to influence consumer behaviour. Specifically, furthering a better understanding of human decision processes and the motivational properties of goal setting could serve as a basis to expand the potential of these new communication possibilities. To this end the research reported in this article has been supported by various Dutch government agencies including Novem (Dutch research for energy management), Stichting Duurzame Energie (Agency for Sustainable Energy), Energie Onderzoek Centrum Nederland (Netherland's Energy Research Center), the Technical University Eindhoven as well as the German and Dutch divisions of the Miele company, an appliance manufacturer.

In turn, goal setting theory can help to guide this research by providing logical and testable hypotheses.

Decision making and choice theories provided an additional conservation tool, anchoring bias. FIT supports the hypothesis that anchoring bias can work in conjunction with goal setting and feedback because it is not likely to interfere with attention to task performance. This allows us to speculate that performing an experiment to confirm the usefulness of a combined application would not be a waste of time or other study resources.

In conclusion, the use of theory has guided a number of applied studies that have successfully, and efficiently, led to a better understanding of methods to increase energy conservation behaviour while further developing the theories for broader generalizability.

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