Using persuasive technology to encourage sustainable behavior

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Abstract
In this paper sustainable consumption is conceptualized as the result of various types of interactions between users and systems. We review attempts to promote sustainable behavior and discuss contributions by using persuasive technology. In particular, we focus on the appraisal of climate risks and interactive approaches to influence energy consumption in households.

1. Introduction

The impact of human activity on the natural environment has severely affected the ecosystems on earth and in the long run might lead to serious threats to human life and civilization. The environmental impact of humans can be roughly assessed as a function of their numbers, their affluence, and the technology they currently use (cf. Ehrlich & Ehrlich, 1991). However, despite the fact that humans have used technology as long as they have consumed natural resources, technology as related to environmental resource use, is often set apart from the study of human behavior and resource conservation. This separation has hampered interventions to protect natural resources and constrain negative environmental impacts.

Various studies have shown that a purely technological approach to reduce energy consumption often leads to disappointing results due to changes in user behaviour, which have been described as rebound effects (Midden, Kaiser, McCalley, 2007). Also, resistance to new systems and negative experiences, for example due to faulty automation or lacking user friendliness, has frustrated the high hopes of innovative technologies. On the other hand, the effects of purely behavioral approaches have been very successful neither or mixed at best (e.g. Weenig & Midden, 1997). One of the main reasons for the lack of success is that most communication programs targeted the intentions of users, but largely ignored the technical context in which consumption choices actually occur. Basically, we view energy efficiency and conservation as the outcomes of multiple interactions between technological systems and human users. It follows that interventions that aim to influence consumption behaviour should be concentrating on guiding interactions between users and systems.

The linkage between technology and sustainable user behavior can be described by distinguishing four roles of technology: (1) as an *intermediary*, where the technology used for attaining a goal defines the ecological impact, although often surrounded by uncertainty; (2) as an *amplifier*, where technology amplifies the human potential to attain goals, but at the same time it amplifies the use of resources (3) as a *determinant,* where behavior is shaped and activated on the basis of the affordances, constraints and cues provided by the technological environment and (4) as a *promoter*, where technology is designed to influence behavioral choices (Midden, Kaiser & McCalley, 2007).

Although it would be worthwhile to consider each of these roles as a perspective to design persuasive interventions that enhance sustainable consumption, we will focus in this contribution on the fourth role of technology, that is the role of promoter.

2. Technology as promoter of sustainable behavior

How can people be motivated to use scarce natural resources in a sustainable way? In the search for effective interventions we ask how persuasive technology can help to overcome some traditional limitations and make motivational strategies more powerful. We discuss this role of technology regarding two foremost challenges that policy-makers and psychologists face in combating the major environmental risks of CO_2-emissions and climate change. First the use of media technologies is explored, to see how they can help enhance problem awareness. Second, we focus on interventions to change behavior and the ways technology can be used to make interventions more effective.

2.1. Using novel media to raise risk awareness

Since the 1970s, worldwide numerous mass-media campaigns have been used to raise concern for the threats to natural eco-systems and the urgency of action. Results have often been disappointing. Among the many issues that have been identified, attention and processing issues form an important part.
Looking at attention rates, many mass-media appear not to be used by the general public. Traditional visual media such as television ads and video-clips have also been used to stimulate environmental awareness and conservation behavior. However, visual media are not more motivating per se for enhancing sustainable *behavior*, in spite of their easy access and less demanding processing (Weenig & Midden, 1997).

More advanced multimedia technologies may add persuasive impact to the traditional communication of transferring symbolic information (like text or speech) by inducing direct sensory experiences like sounds, images, scent and touch that create ’presence’, the feeling of ’being there' in a mediated environment (see for an overview IJsselsteijn, 2004). It may allow people to better conceptualize cause-effect relationships, such as how an urban area would look and feel like without car traffic or how the world would be after serious climate change. More recently, significant research efforts have been directed toward investigating the relation between ’presence’ and emotional impact (measured through, e.g., galvanic skin response or heart rate variability), where findings are supportive of the existence of such a relation, in particular in relation to fear-inducing media environments (Meehan, Razzaque, Whitton, & Brooks, 2003). Research in the domain of environmental risks has convincingly demonstrated the role of affect and emotion in risk perception (e.g., Slovic, Finucane, Peters, & McGregor, 2004,). Some experimental evidence is available which shows that video images with emotionally charged content stimulate attention for climate risks and coping options. The use of intrusive images and dramatic sounds to alert people were found to enhance relevant information processing for coping with these risks (Meijnders, Midden & Wilke, 2001).
These studies suggest a new area of inquiry in which virtual environments can be used to offer new opportunities for technology assessment by giving people pre-experiences of future technology effects or newly planned environments and facilities, which will go beyond verbal descriptions or abstract representations. Ongoing work in the Netherlands focuses on the cognitive and motivational effects on coping behavior as a result of user experiences in a virtual polder environment, which is threatened by dike collapse (Zaalberg & Midden, in preparation).
In sum, traditional media have had limited success in promoting environmental problem awareness, but new multimedia technologies show more promise in this endeavor by offering new opportunities for creating and enriching sensory experiences as a route to raising awareness of future and/or distant issues, to explore cause-effect relationships and to experience environments that are not directly observable. However, despite the

possibilities offered by multi-media technology, raising awareness will not be enough to fight climate risks and diminish the use of natural resources. In the next section we turn to the role of technology in accomplishing behavioral change.

2.2. Using Persuasive Technology to Promote Energy Conservation Behavior

Prior to the 1990's, experiments using electronic devices indicated that they might contribute to the efficiency and effectiveness of behavioral interventions, but technology just wasn't yet smart enough in most cases to make these devices very successful. Psychologists have as yet merely touched upon the opportunities offered by intelligent systems to promote (energy) conservation behavior. Most early work was done on the effects of feedback on energy consumption in the home. Studies often used simple procedures like written messages based on daily or weekly meter readings, while some researchers used electronic displays. Electronic modes of feedback have been proposed to solve a number of issues related to written modes. First, electronic means could provide feedback more quickly and frequently than written feedback, even continuously, thus making the consequences of specific behaviors better available for the consumer. Second, electronic feedback could be given at more central locations like the living room or the kitchen. Third, electronic feedback allows for the use of multiple standards (e.g., personal and social), reference points (e.g., financial costs per hour, the previous day or the upcoming month) and units (e.g., $ or emitted CO_2). Fourth, written feedback provided with a high frequency has been quite effortful and costly. Automation could make the feedback process more efficient. Fifth, instead of the usual aggregated feedback at the household level, electronic feedback could be source-specific (e.g., the airco or the cooker), evidently creating a closer link between feedback and action (e.g. Wood & Newborough, 2003).

In sum, electronic means have made it easy to provide highly frequent feedback, which is more effective. Electronic devices have also facilitated feedback on specific appliances, which appeared to be more effective than general feedback. Goal-setting, added to electronic feedback, enhanced energy savings.

Almost all interventions were designed to communicate with subjects in a one-way direction. Modern intelligent systems enable two-way interaction between user and system, which allows for more precise targeting of tasks and for personalization. To illustrate, interactive systems allow for the implementation of more refined goal-setting procedures and the provision of more specific information, not only to specific appliances but to specific tasks as well. Interactive devices are still rare in the domain of (energy) conservation behavior. Some studies, however, illustrate the potential. The present authors observed in two earlier studies (e.g. McCalley, 2006) energy conservation results up to 20% using washing machines with a user interface that allowed for interactive goal-setting and outcome feedback. During a series of twenty washing tasks, users received immediate feedback each time they made a choice for a washing program to carry out a particular task. Subjects with either self-set or assigned goals saved more energy than subjects without an explicit goal.

Applying intelligent agent technology that learns from the users and interactively communicates on a personal basis could enhance the power of supportive systems. We use the term agent to refer to a piece of software that can be considered as an autonomous creature able to perform tasks with more or less intelligence and autonomy. It can be made visible in many ways through virtual or physical forms of embodiment (e.g. Diesbach & Midgley, 2007). An agent system could be able to frame outcomes based on the current context or user, or to encourage the user to make certain goals more explicit, and even make suggestions on how to act or guide a user to a decision. In this role, intelligent agents may become persuasive social actors, rather than simple tools (e.g. Fogg, 2003). In a very recent study (Midden & Ham, 2008) demonstrated that social feedback from a physically embodied agent, an iCat (Philips company), resulted in significantly more energy conservation behavior on the same washing tasks than the factual feedback like provided in McCalley and Midden study.

3. Conclusion

In this paper we discussed behavioral interventions on enhancing sustainability with a focus on human-technology interactions. Four roles of technology have been suggested and the role of promoter of sustainable behavior has been explored in greater detail. Our review reveals that persuasive technology has much to contribute to the design of effective motivational interventions. It helps to raise awareness of future or distant issues, such as the vast melting of polar ice, or to lower thresholds for change, for example by making it possible to experience a building not yet constructed or to explore cause-and-effect relationships such as the effects of ventilation on air circulation in the home. Technological assistance may go beyond the level of specific appliances or systems and direct energy use. For example, the application of computer and robot technologies to domestic appliances) will be able to monitor multiple sources of energy use and support home energy management. Such systems will offer advice on saving options taking account of personal lifestyles and will even be able to support strategic decisions like investments in equipment and home renovation. Sustainability requires joint efforts in various social groupings (e.g. household, neighborhood). Persuasive systems may also be able to touch this social dimension of sustainable behavior for example by coordinating contributions.

Interventions that aspire to integrate psychological with technological means form a challenging perspective. We believe, however, this effort to be most worthwhile on the route to a society that makes sustainable use of its natural resources.

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