

COLOR, COGNITION, AND RECYCLING: HOW THE DESIGN OF EVERYDAY OBJECTS PROMPT BEHAVIOR CHANGE

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1. Introduction

Sustainability is a significant global concern. The culture of indulgence and consumerism, engrained in modern consumer behavior, has become an established lifestyle that cannot be easily changed. Technological interventions impose extra costs, are not universally feasible, and are ineffective without proper education [Derijcke and Uitzinger, 2006]. Studies indicate that merely focusing on the design of technologically efficient products without recognizing the significant role of users' behavior are destined to fail and do not result in change. We install compact florescent bulbs, but forget to turn them off when leaving the room. We drive fuel-efficient cars, but overuse them, assuming they have less environmental impact. The big challenge in increasing the efficiency of energy use is not primarily technical but behavioral. This paper argues that some behaviors are partly initiated, navigated or changed by the surrounding built environment and this creates an opportunity for design. That is, designers are capable of designing environments that create a demand, an incentive, or a nudge for people to behave one way or another. We apply this logic to the design of recycling bins and assess recycling behavior.

2. Previous work

Most studies of behavior change through product design have focused on usability, particularly, "ease-of-use", through removing barriers to the desired behavior or making the undesired behavior more difficult [Jelsma and Knot, 2002]. Although some studies show that "persuasive" methods promote behavior change, they focus primarily on web-design or public health. Design strategies driven from behavioral theories (such as goal-setting theory or the transtheoretical model of behavior change) ignore a critical component: how technical support for behavior change impacts the individual's social world and integrates into their everyday life. Recently-developed design methods such as the "design with intent" toolkit [Lockton et al. 2009] and the fun theory propose general strategies that do not fully take into account the context and have not been validated. In the realm of product design, eco-feedback is a strategy that has been widely used by designers. Eco-feedback products inform users of the impact of their behavior and hope to change behavior through that knowledge [Lilley et al. 2005]. The eco-feedback strategy involves a process of information transfer either explicitly (e.g., monitoring the electricity consumption, displaying fuel economy in cars) or implicitly through metaphors and symbols (e.g., visual voltage products inform you about your energy consumption behavior through reactions like a blooming lamp for reduced consumption or a power aware cord that gets brighter

when more electricity flows through it, Figure 1). Eco feedback and similar approaches that focus on rational decision-making require congruence between the individual's desired behavior and the feedback (e.g., to change energy consumption behavior the glowing power cord should be treated as information about one's consumption behavior that needs to be changed rather than a novelty or a creative new "night light"). The existing literature on "persuasion" and "motivation" provide general, yet limited, frameworks for designers interested in sustainable, low-cost, product-driven behavior change. In this paper we adapt some theories from the psychology literature and translate them into design elements for designing a recycling bin. We also investigate how manipulations in design can change the behavioral responses of people in the context of recycling.



Figure 1. Visual Voltage products

3. Theoretical Background

The elaboration likelihood model (ELM) of persuasion [Petty and Cacioppo, 1986] suggests that there are two routes to persuasion: the "central route" (high elaboration) where the individual considers an idea logically, and the "peripheral route" where the individual processes the message based on the appearance and environmental characteristics (low elaboration). As mentioned earlier, eco-feedback strategies require careful scrutiny of a persuasive communication and consequently higher cognitive processing so they would be examples of the central route. For highly familiar situations that do not require high levels of attention (e.g. we install compact fluorescent lamps, but forget to turn them off or have recycling bins but discard the recyclables in standard trash cans), it may be more efficient to use a peripheral processing route to trigger behavior change. We argue that in the context of recycling, if we assume that our population is familiar with the concept and is not opposed to it, eliciting attention to the behavior could be achieved through a peripheral route of "visual salience" of recycling products or cues. Visual salience is "the distinct subjective perceptual quality which makes some items in the world stand out from their neighbors and immediately grab our attention" [Itti, 2007]. Salience is the result of interaction of one element with another, as well as with a visual system (biological or artificial). That is primarily a "bottom-up, stimulus-driven" signal but it can be overridden by "top-down, user-driven" factors [Desimone & Duncan, 1995; Itti & Koch, 2001]. Visual salience can be achieved through the contrast between a number of simple visual elements or properties such as color, edge orientation, luminance, and motion direction [Treisman & Gelade, 1980; Itti & Koch, 2001].

We hypothesize that the visual salience of recycling bins encourages recycling behavior, presumably through a peripheral route of persuasion. In other words, if a recycling bin is highly visible, stands out relative to other neighboring objects, and elicits attention, it will be more likely to promote the associated behavior of recycling. We predict that salience will increase the probability that the recycling bin will be seen and used (assuming all other aspects are equal). Formally, our hypothesis can be stated as:

H: Salient Colors increase the use of recycling bins, assuming all other aspects being equal.

4. Method

4.1 Pilot Study

In order to find the right stimuli (salient color for recycle bin) and design study 1, we conducted a pilot study. In this pilot study we were interested to see how well different colors on a recycling bin exhibit salience. The dependent variable is “recall” of a recycling bin in both cued and no cued conditions (in this pilot study we did not measure use). For the recycling bins and trashcans, we used three different color hues (red, green, blue) and a medium grey with the same level of brightness and saturation.

Method: We took a photo in the same experimental lab that will be used Study 1. We then created four images in which we imbedded a recycling bin in one of the four colors of interest in the same location in the room, and created four experimental design conditions. We designed an online survey in which subjects used their own computers and were randomly assigned to one of the four conditions and exposed to the photo for 3 seconds. They were then asked to list 8 objects they remembered from the photo. We then asked them whether they saw a recycling bin or not and if their answer was “yes”, asked them to mark the location of the recycling bin. We also asked about the monitor size and colorblindness of participants. We excluded the data for colorblind subjects. The subjects were not able to take the survey if the monitor size was smaller than 21 inches. All subjects were required to run the survey in a full screen mode.

Results: Ninety-nine subjects (50 females) from Amazon Mechanical Turk (Mturk) subject pool participated in the pilot study; 52.5% listed the Recycling bin/trashcan as an object they remembered from the photo and 58% of subjects marked the right location. The general pattern of results showed that green was the most memorable color, while red and grey were the least memorable colors (Figure 2, left). Omnibus logistic regression analysis showed a significant effect of color ($Z=2.84$, $p = .043$). A planned contrast test revealed that in the no cue condition green is significantly more memorable than grey ($Z=2.37$, $p = .018$) and red ($Z=2.23$, $p = .025$). We observed the same pattern for the second question using cued recall (Figure 2, right). In the cued condition, in addition to green being more memorable than red and grey, blue was also significantly more visible than grey ($Z=2.22$, $p = .028$).

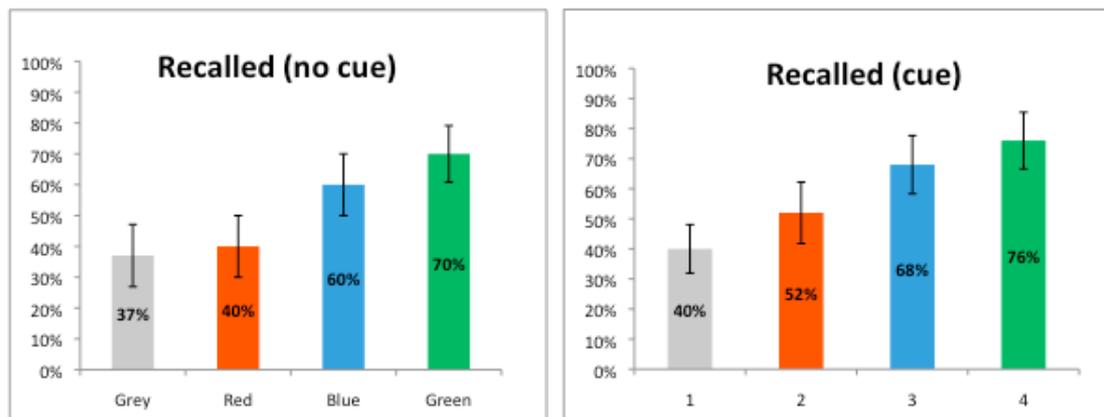


Figure 2. Recalling the recycling bin without cue (left) and after cue presented (right)

Discussion: This pretest indicated that different colors affect the memorability of a recycling bin in both cued and non-cued settings. This helped us decide which colors to use in Study 1, which was intended to examine actual recycling behavior. In Study 1 we tested the hypothesis that visual salience of a recycling bin affects the probability of its use.

4.2 Study 1

The major goal of this study was to examine whether the salience of a recycling bin leads to a greater likelihood of recycling behavior. The experiment had two conditions: high-salience and low-salience.

The high-salience condition was represented by a green recycling bin next to a grey trashcan in which the color contrast of two bins added to the salience of the bin, whereas in the low-salience condition two grey bins were differentiated either as a recycling bin or trashcan only by a black and white label. Therefore, we compared a green and a grey recycling bin (all other aspects such as size and shape being equal) by placing it beside a grey trashcan, and measured the proportion of participants who recycle. All bins were labeled as either “TRASH” or “RECYCLE” in black on a white background with the same font style, font size, and color. Since subjects might behave differently if they were to notice that they are being watched, especially in the context of pro-social behavior, observations were discreet so participants were not aware of the purpose of the study or that their recycling behavior was being observed.

Method: We positioned a recycling bin (grey or green, depending on condition) in an experimental lab located at The University of Michigan. We also located a grey trashcan with the same shape and size 35cm away from the recycling bin. Subjects signed up to take a set of surveys for course credit or hourly payment. For their final task, they were asked to engage in a task that involved tearing some papers. They were asked to go to a table at the corner of the room containing the materials for the experiment (instruction paper, a letter size label, and an empty bottle), and return to their seats to do the task. For the task, they were asked to choose one label for an orange juice container (among the four printed designs on a paper) that best fits the form of the bottle, cut it out, role it onto the bottle, return the bottle to the lab assistant, and clean up the unused materials. The lab assistant refused to take anything except the bottles from participants and asked them to “throw it out” while pointing to the area where the trashcan and recycling bin were located. However, since the bins were behind him, he could not directly observe the behavior. We arranged participants to start and finish the task at scattered time intervals so that no two participants could use the bin at the same time. Additionally, subjects were separated by cubicles and could not see each other. Therefore, we guarded against the potential effect of social conformity on subjects’ behavior. We counterbalanced the location of the recycling bin and trashcan to control for order effects and proximity/distance effects.

Results: Forty-eight undergraduate students participated in the study and were randomly assigned to either the high-salience (Green, n=25) or low-salience (Grey, n=23) conditions. We found that 88% of subjects in the high-salience condition (green R-bin) recycled, whereas only 52% of subjects used the recycling bin in low-salience condition (grey) (Figure 3). Statistical analysis shows a significant difference between the proportions in these two groups ($Z= 2.73, P= 0.006$).

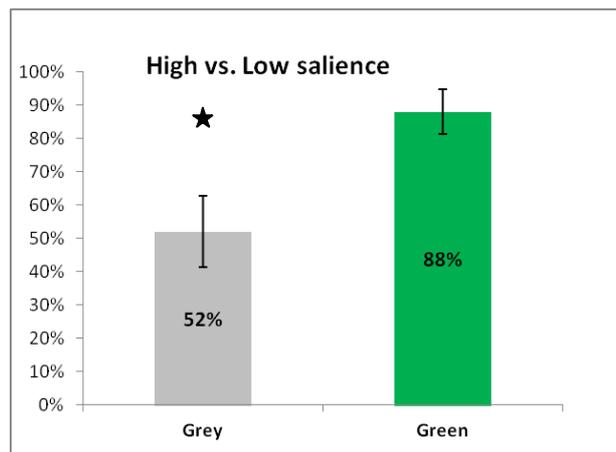


Figure 3. The ratio of recycled to total in High vs. Low salience condition

5. Discussion of results

We found that color can affect the salience of an object and consequently trigger the associated desired behavior. However, it remains unclear why the green recycling bin has a higher salience

compared to the grey recycling bin and the underlying psychological mechanism that implicitly triggers the associated behavior. The salience of the green recycling bin could be due to the higher arousal level of green compared to grey or induced arousal by the color contrast (vs. no contrast in grey trashcan-grey recycling bin condition). Further, the salience of the green recycling bin might be explained by something beyond the mere physiological accounts: the meaning of color. Although most of recycling bins in U.S. are blue, the color green is typically attributed to sustainability and eco-friendliness. Thus, people might recognize a green recycling bin faster than a red one because of the consistency of color meaning with the context of application. There is also other literature [Mehta and Zhu, 2009] affirming that blue or green (versus red) can activate an approach (versus avoidance) motivation. Additional studies are needed to tease out whether salience of green is due to arousal, symbolic meaning or motivational implications and to elucidate the underlying mechanism.

6. Conclusion

We used the theory of ELM and visual salience from the psychology literature and applied it in the context of design for behavior change. The case study of recycling bins revealed that people recycle more in a green recycling bin versus a grey one, if all of the other aspects (ease of use, availability/access, size, function, shape, and material) are equivalent. The results suggest the role played by design principles as peripheral cues in steering underlying mechanisms of behavior change. They also highlight the importance of low-cost implicit incentives in triggering the desired behavior compared to the traditional high-level, knowledge-based cognitive processing. The next step would involve a set of studies to shed light on these results and the mechanism that resulted in the salience of the green recycling bin. Furthermore, we are interested in investigating the extension and implication of this case study to other behavior change paradigms. We will also develop a framework for designers of persuasive products and systems to successfully produce behavior change through design.

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