A Long-term Study of User Experience Towards Interaction Designs that Support Behavior Change

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Abstract
Many researches on interaction design that supports users' behavior change in everyday life are studied recently especially in the domain of pervasive technology. However, not much attention has been paid to long-term effects on users in such cases. This paper presents our initial work of a long-term (8 month) study of users' self-report of experiences with an ambient dashboard feedback system in an automobile called *Eco-driving system*. It was notable that user satisfaction changed positively following active self-efforts made by users to understand the system after the negative shift due to initial disappointment. This work will be a first step to build a framework of how users accept systems designed to persuade them to change behavior over time.

Keywords
Persuasive technology, interaction design, long-term, behavior change, eco-driving, user satisfaction

ACM Classification Keywords
H5.m. Information interfaces and presentation: Miscellaneous.

General Terms
Design

Introduction
Interaction designs that support users' behavior change in everyday life are more and more common recently. Many projects have attempted to help people achieve behavior change based on *persuasive technology* [3]. However, it is not actually easy to change attitudes or behaviors of people. Especially getting an individual to change her everyday behaviors, and hence her lifestyle, is even more challenging [2]. Although these attempts do not use coercion [3], negative emotional response can be induced. Since the negative feeling of user can reject design itself, understanding and handling user response is important.

Some design theories or strategies [9, 12] were developed based on the field of psychology to understand user behavior according to the changing demand. While these researches show how effectively we can change user behaviors through persuasive technology, they were less focused on user's *satisfaction* [10] aside from the success of *persuasion*. In terms of the period of a behavior change of a person, especially habitual changes, it is not happen immediately but through a long time [6]. In many cases, nonetheless, only the immediate behavior changes are studied [5, 9].

In this paper, we tried to understand the effects of an interaction design that helps behavior changes on people throughout a *long time*, by focusing on users' *satisfaction*. For this, as an initial exploratory study for long-term research, we conducted a tracking observation on 57 users of an existing design example of the *Eco-driving system* for 8 months. Through this study, we wanted to understand the long-term pattern of changing users' satisfaction and what factors induced such a pattern. Based on this understanding, we discussed implications for behavior-changing interaction designs in a long term.

Related Works
In terms of persuasive technology, which is defined as any interactive computing system designed to change people's attitudes or behaviors [3], many behavioral theories were studied and referred by designers. *Goal-Setting Theory* [11] describes how individuals respond to different types of goals and thus which tend to motivate well. *Transtheoretical Model* [14] identifies four independent stages. These theories provide useful guidelines for design, but do not provide actual users' responses in terms of interaction design that support behavior change in the real context. Thus many projects have attempted based on these persuasion techniques and models to achieve the desired behavior change, and evaluated. Their evaluation all shows that their design could make positive changes in human behavior. However they evaluated only the instant behavior change not long-term change which might be really called behavior change in everyday life.

There are few researches tried to understand long-term responses. Gasser et al. [4] conducted a 28-day field study for comparing usage and acceptance of a mobile lifestyle coaching application. Karapanos et al. [6] conducted five-week ethnographic study for understanding user experience over time. We referred their methods for our eight-month research. In terms of the case we covered in this study, some researches designed the similar systems with the system we

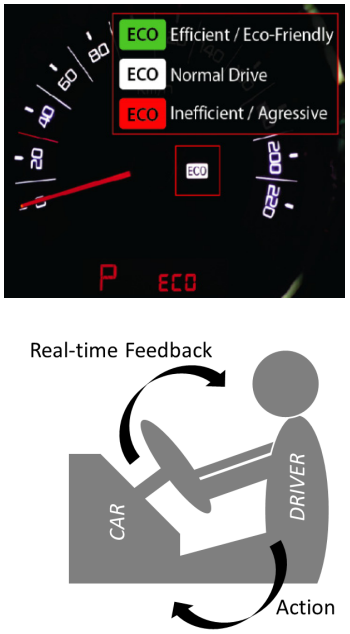

Figure 1. Eco-driving system (top) and its mechanism of changing driving behavior (bottom, driver-system interaction)

observed for our study. Pace et al. [13] designed a feedback system to encourage more fuel-efficient driving habits among school-bus. Meschtscherjakov et al. [12] presented future persuasive in-car interaction approaches for a more economic driving behavior. But their evaluation was also limited to the instant responses, and they were evaluated not in the real use context.

Study Design

The present study selected the *Eco-driving system* as an example of interactive designs helping change daily driving habits, and observed shifts in satisfaction of the system over a period of 8 months for the first-time users of the system.

Research on in-car interfaces has recently gained higher attention in the area of HCI [4]. An *Eco-driving system* is one of those attempts, which is designed to promote an eco-friendly and cost-efficient driving habit. As the drivers' interest in the economic driving is becoming greater, many automobile companies are applying such a function to their vehicles.

The Eco-driving system of KIA Motors studied here is embedded in the dashboard to show how efficient and eco-friendly a person is driving in real time through different colors [8]. (Green: Highly efficient; White: Moderately efficient; Red: Inefficient) (Figure 1, top). By analyzing drivers' behaviors, the system provides real-time feedback for drivers so that they can correct their driving behaviors (Figure 1, bottom). Particularly, this cycle happens in a daily living task of driving in a natural way ultimately to change driving habits through recurring interactions between a driver and the system.

For a study methodology for understanding the change in users' experience and behavior over time, we conduct our study with a *longitudinal* approach [7], which takes several measurements during the experience time and, thus, enable greater insight into the exact form of change. Since we wanted to trace users as long as possible, main challenge was that how to trace users' experience during long period without any interruption. We worried about user's mental load for well-structured questions for longitudinal study since they have to fill out same questionnaires repetitively. We therefore measured single reliable variable, *user satisfaction* [10], as users strive for a more satisfying interactive experience [1]. Instead of collecting different variables which make possible to quantitative analysis for different factors, in this study, we asked open-ended question and debriefing interview to understand what factors affect user experience.

As a result, we conducted study for 8 months with a total of 57 owner drivers of the car with this system (KIA Forte 2010 model, medium-size sedan) were asked to fill in monthly online questionnaires starting from the month of their purchase. In sum, a total of 453 survey results from 57 drivers (avg. age=29.4, SD age=9.4, 48 men) were collected. In each questionnaire, the satisfaction level of the eco-driving system at each point of the time was marked within 7-point Likert Scale followed by an open-ended question. The question was *"How do you satisfy with your Eco-driving system without considering other aspects of automobile? And why?"*. After collecting these data, we conducted debriefing interview every month in case we couldn't fully understand participant's open-ended response.

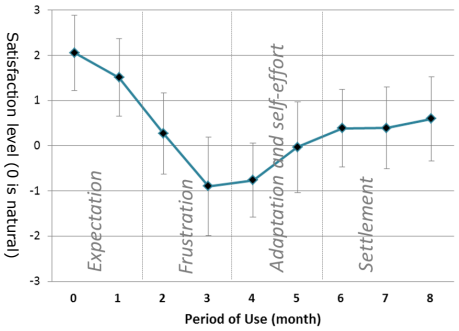

Figure 2. Long-term pattern of average satisfaction variation (with standard deviation) regarding Eco-driving system

Results and Discussions

The 8-month satisfaction rating analysis found interesting results (Figure 2). Satisfaction was found very high for the first month followed by a drop in the 2nd and 3rd months. Interestingly, the satisfaction started to rise in the 4th month and reached a stable state in the 6th month. In this initial study we focus on open-ended descriptive user responses and debriefing interview which explain how and why user satisfaction is changed.

Month 1: High expectation to the system

"My old car had no system like this. It is interesting and fun (P4)", "I am wondering how much the fuel efficiency will improve (P13)", "Maintaining the blue light feels as if it is a game and I feel better (P42)"

Users first expected the system to change their driving habits positively. Since the car company promotes this system a lot, every participant knows this system when they purchase the car. Then, as Silverstone and Haddon [15] mentioned, they form expectations about ways in which the product could become relevant to their lives. This high expectation first turned into high satisfaction due to the having that new function. Also, curiosity toward the novel and unfamiliar system led them to have positive expectation and high satisfaction. At the same time, some respondents stated keeping the blue icon implying the highest fuel efficiency flashing added much to a *game-like fun* while driving.

Month 2~3: Drop in satisfaction

"When driving itself is difficult, I feel very stressful to even think about the indicator light (P12)", "The red icon flashing in case of sudden speed boost feels like a warning against me (P33)", "I know well I am accelerating out of nowhere, which need not be warned. I can control myself (P51)"

In a month, the initial satisfaction for the system is beginning to drop. Quite a few drivers felt it unpleasant to see the red light flashing, signaling inefficient driving as if it forced them to change their attitude. As such, the initial positive satisfaction took a negative turn among users, who tried to ignore the system.

Month 4~5: Rebound of Satisfaction

"I just think it as it is (P9)", "It was meant to be good for me, so I am to take advantage of it. Otherwise, I would feel I'm losing something (P31)", "I've decided to trust and follow the system once again for better fuel efficiency.(P39)"

Interestingly, following the initial high expectation turning into disappointment, users tried to understand the system from a positive perspective. Rather than a vague expectation that their behavior would change, users are trying to find their own goodness [6] of design. They came to recognize that they could use the system on their own to make it a useful tool, whose attitude contributed to the gradual and stable positive turn.

Month 6~8: Maintenance

'It is great once you use it for a while to get used to it (P36)', 'There is nothing to lose by listening to it (P49)'

After five months to the first experience of using the system, satisfaction did not change much, but was maintained based on the previous experience.

First thing we discussed is that it is difficult to assume that such a pattern is applied to all the designs for behavior change. The largest characteristic of this case

is the fact that most of the users already knew about the eco-driving system, and they selected this product. This seemed to trigger the high satisfaction in the first stage from the prior expectation [15]. Other cases where users encounter products accidentally would result in different initial responses.

Disappointment results from several causes. Here, the *red flash* was found a major cause triggering unpleasant feeling. In fact, this seems not to be a good design given the guideline that suggests users should not be irritated and coerced. [3]. In addition to simple visual warnings, the red flashing light was found to impose a sense of *guilt*. Some interesting responses include: *"I don't agree that I am damaging the environment even though I step on the accelerator all of a sudden. Look around at those SUVs with larger engine displacement!* (The cars studied here were small ones) *(P20)", "It'd be better not to treat me like a sinner. Just do it as the speedometer (P36)"*. Other similar projects aside from the vehicle used in the experiment apply metaphors related to the environment such as a fading leaf [13]. Although it may seem interesting, our results say that it can be encountered negatively in the actual use.

The most impressive aspect is the adjustment step followed by the disappointment. Although 87% of the users showed a *negative* satisfaction within the initial 4 months, 73% of their satisfaction turned into a *positive* one after 4 months. The reason for such a rebound seems that a user becomes familiar with the unpleasant feedback as the time passes while strongly agreeing to the improvement of fuel efficiency that the system is promoting and begins to try to use the system as a beneficial tool to herself.

We also could find several interesting findings from open-ended results. The change of fuel efficiency (or the outcome of the behavior change) itself was not mentioned in the answers for the reason of change in the satisfaction. Although users can observe the fuel efficiency via the average fuel efficiency display, they were more affected by the belief that the fuel efficiency can be improved in the future or not. Another interesting point was that some users initially found the system to be like playing games full of fun (8 out of 57), which was hard to find after 3 months. This finding indicates that *'fun'* factors may not work over time although many designs adopt those factors as motives for behavioral changes.

Lastly, the study results clearly show that the effects of a design for an everyday behavior change must not be studied momentarily but observed for a long-term change. If the evaluation for this case was done at the very initial stage, the results would have been good due to the expectation for the new function and if conducted after 3 months, the results would have been negative. However both of them could not have told the results after 8 months.

Conclusions and Future Works

This paper presents our initial work of a long-term (8 month) study of users' self-report of experiences with an ambient dashboard feedback system in an automobile. It was notable that user satisfaction changed positively following active self-efforts made by users to understand the system after the negative shift due to initial disappointment. Rather than any improvement in motivation as a result of actual changes in behaviors, beliefs that things would change in the future were more significant factors. Also,

curiosity-driven fun factors were found to contribute to increase in positive satisfaction, but did not last long. The findings in this study suggest that the influence of designs on behavioral changes in daily lives should be viewed not from a transient but long-term perspective.

Meanwhile, designs intending to change behaviors aim at behavioral shifts. In that sense, the present study should have focused on actual behavioral changes, namely the improvement of fuel efficiency, as well. A precise understanding of actual behavioral changes over a long-term period could guarantee further in-depth analysis with more sophisticated methodology by measuring more variables. These further studies will build a framework of how users accept systems designed to persuade them to change behavior over time.

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