Save the Kiwi: Encouraging Better Food Management through Behaviour Change and Persuasive Design Theories in a Mobile App

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Abstract

Managing food waste is a means to improve our environmental and economic sustainability, and is achievable both societally and personally. We conceptualized "Save the Kiwi", a personal mobile application that communicates food safety information to encourage better food management, primarily in consuming purchased food products before they expire. Instead of simply relaying food information to its user, the application combines elements of behaviour change and persuasive design theories, and uses personified icons to notify its user about the expiry conditions of the associated food items. In an exploratory study, we found that the application has the potential to help users reduce their food waste. We discuss our results and recommend future work to create a viable solution to address food waste issues.

Author Keywords

Food Waste; Food Safety; Behaviour Change; Persuasive Technology; Mobile Applications

ACM Classification Keywords

H.5.2. *User Interfaces – Graphical user interfaces (GUI)*

Introduction

Poor food management is a common issue in our society. It typically leads to food expiring and ending up in the landfill, incurring high environmental and economic costs [3]; or people ingesting it and become ill. One way to address this issue through technology is to manage food expiration dates in a mobile app [10], where the user receives notifications when a food item is about to expire. However, these apps typically only provide expiration information in a factual way, without any persuasive mechanisms such as positive and negative reinforcements, which are effective in promoting behaviour change [2].

We propose incorporating behaviour change and persuasive design theories [2,6] into the design of a mobile app, and conceptualized "Save the Kiwi" as an illustration. We drew inspiration from Farr-Wharton et al.'s [1] study of factors that promote domestic food waste, and focused on the visibility of food inventory [5]. The overall goal is to effectively communicate consumption information about food products and encourage users to act on it using principles of operant conditioning in persuasive design [6].

In this paper, we present our "Save the Kiwi" mobile app concept and the theories behind its interface design, followed by a description of the exploratory study we conducted. We aim to use this study to validate our concept and design, and lay the foundation to a longitudinal study in measuring the effectiveness of the app in the long run as a behaviour changing tool.

Food Waste: Causes and Proposed Solutions

Farr-Wharton et al. [1] conducted a 3-month study examining the impact of consumer decision-making behaviour regarding food and wastage, and concluded that most wastage behaviour arose from poor food storage information availability. For example, people stockpiled food because they did not know they had already owned enough. Moreover, Ganglbauer et al. [4] found that consumers had various reasons to not throw away food, such as sustainability, budget, or ethical concerns. Overall, bulk purchases, poor planning, lack of communication with other household members, inability to track inventory, and busy and erratic lives were factors contributing to unwanted food wastage.

To address these causes, researchers have suggested mechanisms that provide real-time information of current food stocks during food purchasing [1], make information visible and accessible [5], and share recipes that use ingredients that are available [9]; typically achieved by mobile technologies.

Behaviour Change and Persuasion Theories

Advances in technology have enabled it to be a means for persuasion. Fogg [2] defined persuasive technology as "interactive computing system designed to change people's attitudes or behaviours", which focuses on random positive reinforcement for effective behaviour change. Kirman et al. [6] further suggested that increasing level of feedback frequency by including negative reinforcement and punishment, and adapting the technology to individual users by constantly evaluating the effectiveness of the feedback, would be more effective in enforcing behaviour changes.

An example of persuasive technology related to food consumption is the WaterCoaster by Lessel et al. [7], a mobile app designed to motivate people to drink beverages more often. The app used positive and

Figure 1: Each icon indicating a different state (top to bottom): smiling when being consumed, uncertain when about to expire, and frowning when being wasted.

negative reinforcements by representing the beverages consumed as water level in a tank holding a virtual character, which changed facial expressions to create feelings of empathy. After a three-week study, the authors found that participants were motivated to drink more often, and would continue to use the app.

Save the Kiwi Mobile App

Our "Save the Kiwi" mobile app targets one of the key food waste causes identified by Farr-Wharton et al. [1]: the lack of real-time food storage information. It also uses the operant conditioning modes described by Kirman et al. [6] as a means to persuade users to consume their food, by alerting them of their food's best before dates, and providing visibility to the date after which the food should no longer be consumed.

We imagine this app would be part of a digital food inventory system, in which food can be scanned into the inventory database using bar codes or labels attached to the containers, or as our food purchases become increasingly digitized, uploaded automatically. The app would then act as an interface between the scanner, inventory database, and its user, relaying timely food information.

Application Interface
The app uses a simple design to help user focus on the information provided. For example, it uses illustrated icons instead of lengthy text to represent food items in the system. Each icon is a caricature of the food item, and personifies the item through the inclusion of eyes and facial expressions representing different food states, making it more relatable to the user (Figure 1).

The app has two main sections: the fridge, where its user accesses and manages food information; and the profile, where its user accesses their personal data related to their food usage and general app usage. Within the fridge section, the user can find out what food items are in the fridge, their quantities, their expiry date, and if any of the food was wasted in the past. The profile section lets the user to see their current standing, including the total amount of food wasted, or "saved", and recipes used to "save" food in the past. It also collects historical data of the food items, and provides information to the user about their usage pattern and monetary costs over time.

Operant Conditioning and Achievement System
The app uses the three operant conditioning modes described by Kirman et al. [6] to promote behaviour change, namely, positive reinforcement, negative reinforcement, and punishment. Specifically, it uses an achievement system to realize these modes where users earn or lose points, and cause visible changes in the icons representing the food, as detailed below:

Positive reinforcement – the app rewards food usage, and repeated purchase and consumption of previously used food. This leads to an increase in points, a presentation of the food with happy expressions, a heroic profile character, and awards for challenges accomplished related to the use of food.

Negative reinforcement – the app dissuades letting food in the fridge expire. Failure to do so results in persistent notifications related to food starting to age, presentation of the aged food with worried expressions, and messages with poignantly worded prompts blaming the user of "killing" food. The profile section will also display costs incurred by the wasted food.

Figure 2: The main app interface showing the user profile section. Top: food warrior profile who successfully use a lot of food. Bottom: food murderer profile struggling to reduce food waste.

Punishment – the app penalizes behaviours of wasting food, and escalates for repeated actions. Forms of punishment include removal of points for wasting food, with increasing amount when the same kind is being wasted, presentation of food in question with a sad expression, and a villainous profile character. Wasting food also hinders progress, and increases required food use to complete an achievement.

Additionally, the app uses visibility of food inventory to support decision making related to food use prior to food expiration, and to make its user aware of their behaviour over time and encourage change through this awareness. For example, the app provides clear representations of the available food items (names and pictures), their quantity, and their best-before and eat-by dates. It also presents historical use of food (waste and use), along with its costs, in a highly visible way (simple icons and symbols).

Exploratory Study

To validate our concept and design, we conducted a study that focused on the emotional language and sentiment reported by our sample users in a controlled environment. We aimed at determining if they believed that the app would be effective in helping them change their food consumption behaviour, and if different operant conditioning modes had different effects.

App Prototype
Since we were mostly interested in the interface design, we created a prototype version of our app using an online collaborative prototyping tool (UXPin, www.uxpin.com). This tools allowed us to quickly mockup our interface in high fidelity. It also supported touch and swipe gestures, thus allowing our users to

interact with the interface as designed. We created all the necessary pages and dialogues that users would encounter throughout the study, giving the perception of completion and navigation through the app.

Methodology
The study adopted a between-subject design, where half of the participants received a profile of a user who had successfully used a lot of food (food warrior, Figure 2 top), and the other half received a profile of a wasteful user (food murderer, Figure 2 bottom). All participants underwent the same tasks in the same order, which included positive and negative reinforcements, and punishments as conditions.

We asked each participant to complete five tasks designed to demonstrate the core design features of the app. These features emphasized the contrast between the three conditions. We gave all participants a short introduction to the application, including the background of their profile, and told them to imagine themselves having used the app for a few days.

We collected audio recordings of participants' verbal feedback and think-aloud processes, which we used to gather insights from their reactions and thinking processes. At the end of the study we interviewed them and asked them to complete a survey reporting their experience with the prototype, focusing on the perceived efficacy and likelihood of using the app.

We recruited twelve adult participants (six male) from our campus, none of them had enrolled in any meal plans and hence had to purchase food by themselves. All participants had recently been to the groceries, and had thrown away food in the previous month.
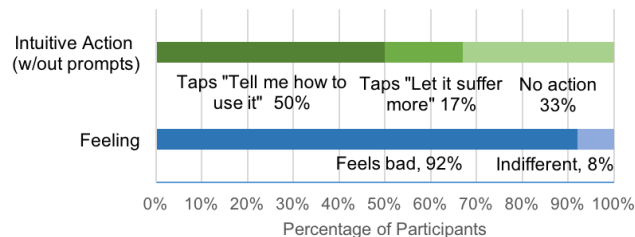
Reaction	Sample of Oral Responses
Positive	"Flattered" "Pretty cool" "Positive feeling"
Negative	"Oh No!" "Guilty" "A lot worse"
Neutral	"I don't really feel anything" "Neither good nor bad""

Table 1: Examples of manual coding of emotional reaction.

Results

We used our observations and recordings collected during the study, and participants' answers to the post-study questionnaire, to understand their perception and attitude towards the interface of the app prototype. We also used manual coding to categorize oral responses to identify and classify their emotional reactions.

All participants reported feeling "happy" or "good" when using the prototype. When we asked them to check a food's status from the notification page, all stated they would choose to "save" the food, rather than "toss it". When they were asked to "toss it", 92% felt "bad" and "guilty", as shown in Figure 3. Furthermore, before we asked them to choose "I am a terrible person, kill it", half of the participants indicated that they would have chosen "tell me how to use it" to see a recipe that can consume the food, while 17% would have chosen "let it suffer more" to consume it later.

Figure 3: Participants' emotional reactions when asked to "toss" the food item during the study.

We coded participants' emotional reactions to the interface using their oral responses (Table 1). For example, when called out as a murderer (a form of punishment), "Oh No!" would be coded as a negative reaction. The good profile (food warrior) elicited positive emotional across all participants, whereas the bad profile (food murderer) elicited negative reactions in 83% of the participants (the rest showed no responses). A Mann-Whitney U Test indicated that viewing the good profile resulted in significantly more positive emotional reactions than that by the bad profile ($W_s=21.00, z=-3.32, p=.002$), and the bad profile had an opposite significant effect in negative emotional reactions ($W_s=24.00, z=-2.80, p=.015$).

All participants indicated that the app would help them waste less food. Responses included sentiments that it would help them waste less, buy less, be more organized, keep track of their fridge, and be more aware of their food items. Participants also reported that they felt like they were being pushed by the app to do the right thing and were motivated by it to perform better in the future. For example, a participant who saw the good profile mentioned "*I want to fill up this progress bar. I want to get to the next level. Fells like an accomplishment out of just saving food*". On the other hand, participants who saw the bad profile commented "*I would like to get that ratio up more, I do not want to waste any*", and "*there is a lot more incentive going on*" when they were told that the app would take away even more points when they wasted their food again.

Many participants identified the visibility of the food inventory as a helpful tool for them to understand what they already had, organize their food better, and use their food before it became waste. Participants also reported feeling specifically motivated by the "money lost" metric presented with the user's profile.

Three quarters of participants identified that they were "extremely likely" or "very likely" to use an app like

"Save the Kiwi" to manage their food items and fridge, with all but one indicating that they would use it weekly or daily. If "Save the Kiwi" was publicly available, 67% stated that they were "extremely likely" or "very likely" to download and use this app, and 83% stated that they were "extremely likely" or "very likely" to share and recommend this app to others.

Discussion

Overall, we found our app to be effective at changing food waste behaviour based on the feedback from our participants. The use of operant conditioning modes in the form of good/bad profiles, personified food items, and achievement system appeared to elicit emotional responses from our participants as planned, motivating them to better manage their food consumption.

Moreover, we found that negative reinforcement and punishment increased the motivation to change more than positive reinforcement, as participants were more likely to "right the wrong". Yet, positive reinforcement still appeared to motivate maintenance of good behaviour and is therefore beneficial to be included.

Our results are limited by the study's sample size and missing of a control condition without any operant conditioning modes and personified icons. We were therefore not able to compare and generalize our results. Also, a limited time frame of the study had hindered us from drawing any comprehensive conclusion on the long-term effects of the app. Nevertheless, we were able to validate the *potential* of our app in encouraging behaviour change based on the feedback from our participants.

Conclusion and Future Work

We conceptualized a mobile app, "Save the Kiwi", to encourage better food management, and distinguished it from existing ones by incorporating persuasive theories in its interface design. Specifically, we used three modes of operant conditioning (positive, negative reinforcement and punishment) and personified icons to elicit emotional responses of its users to promote food consumption. We also made the food usage history more visible to increase its users' understanding of their food purchasing and consumption behaviours.

Participants in our exploratory study have responded positively to our app design and commended the utility of the app, leading us to believe that our design had the potential to result in behaviour change. Our study also showed that, while all the three modes of operant conditioning were effective, negative reinforcement and punishment (e.g., bad profile, sad food icons) appeared to be more effective by eliciting the desire to change. Most participants also indicated that they would keep using and recommend this app to others.

This work is an initial step towards designing a better system to reduce daily food waste through persuasive technology. We recommend future work in both the application and system to further develop this concept, and to better evaluate it through longitudinal studies with more detailed measurements [8] and its effects on a larger and more varied population.

Acknowledgements

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