Reflecting on health: A system for students to monitor diet and exercise

Brandon Brown
School of Literature
Communication and Culture
Georgia Institute of Technology
686 Cherry Street
Atlanta, GA 30332-0165
Brandon.Brown@gatech.edu

Marshini Chetty
GVU Center
Georgia Institute of Technology
85 5th Street NW
Atlanta, GA 30332-0670
marshini@cc.gatech.edu

Andrea Grimes
GVU Center
Georgia Institute of Technology
85 5th Street NW
Atlanta, GA 30332-0670
agrimes@cc.gatech.edu

Ellie Harmon
GVU Center
Georgia Institute of Technology
85 5th Street NW
Atlanta, GA 30332-0670
ellie@cc.gatech.edu

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Abstract
Using an iterative design process, we designed and evaluated a system for college students to encourage the development and maintenance of healthy diet and exercise habits. The system has three components: a camera phone application to support photographic diet and exercise journaling, an automatic workout tracking application for exercise machines in the gym, and a visualization application to support users as they reflect on their diet and exercise activities.

Keywords
Diet, exercise, visualization, mobile phone, journaling

ACM Classification Keywords
H.5.2 User Interfaces

Introduction
In the United States, sedentary lifestyles and poor eating habits are often precursors for weight gain, disease and death [6]. College students comprise one segment of the population that is prone to weight problems. For example, college freshmen gain an average of 4.2 pounds in their first twelve weeks of school [3]. Since prevention is better than cure, college students, who are still forming their long-term lifestyle patterns, should be encouraged to develop and maintain healthy lifestyle habits. Many existing systems designed for monitoring diet and exercise habits are

Figure 1. MIT researchers developed an approach to weight loss tracking that centered on a robotic dog (the Sony Aibo™ device that they utilized is shown above) [2]. The system is composed of a wireless pedometer and a PDA form for textual journal entry. The robot has wireless access to information from these devices and modifies its behavior depending on the user's information. One of the goals of this research is to help users be more aware of their fitness progress. Our system design was motivated in part by this same goal.

The process of journal keeping is another effective way of becoming aware of one's diet and exercise habits [5]. Many current journaling systems are implemented as web applications (e.g., www.fitday.com). Such websites allow individuals to keep a textual log of what they eat and how they exercise. Visualization is usually provided using charts and graphs to show the user's progress over time. One drawback for the user is that when they do not have internet access during the day, they may need to keep a mental or written record of their activities until they are able to login to the application. The Fitlinxx system partially removes that burden by automatically tracking workouts on gym exercise machines (www.fitlinxx.com). In our design we have tried to further compensate for this problem by utilizing the cell phone platform, a device that many people have with them continuously throughout the day.

time-consuming and do not necessarily highlight the tight relationship between diet and exercise. Because of their busy and mobile lifestyles, students require a monitoring system that supports lightweight interaction. To encourage development of healthy lifestyles, a monitoring system should focus on both diet and exercise.

With these concerns in mind, we designed a personal diet and exercise monitoring system for college students, though future work may determine that our system is applicable to a broader spectrum of the population. Our system utilizes photography to provide a rich picture of each user's diet and exercise practices. Pictures of food and exercise provide a visual medium and starting point for users to reflect on the diet and exercise choices they have made which may influence their future health choices. In this paper, we describe our system design and how we arrived at this design through a review of related work and formative and summative evaluations.

Related Work

There are a myriad of different systems for monitoring diet and exercise (see Figure 1) and our research seeks to add to this work by providing an alternative for individuals to visualize their diet and exercise habits. We were motivated by prior work focused on the use of "imagery as data". Frost and Smith introduced photography as a form of qualitative data collection to help diabetics reflect on the potential effects of everyday activities on their long-term health [1]. Participants found that photographs increased their overall awareness of how their environment affects their health and their lifestyle choices. To contextualize the photographs, researchers developed an interface for visualizing correlations between diet, exercise, and glucose levels. Rather than focus on precise accuracy, this visualization provided an overview of collected data that inspired participants to ask questions about possible relationships and reflect on their choices [1].

Formative Evaluation

To understand the needs of our target population, we conducted interviews with 16 Georgia Tech students. In the interviews, most students expressed a desire to be healthy but some were more motivated than others to monitor their diet and exercise habits. Several participants expressed that keeping some type of journal was useful for tracking their dietary and exercise choices. More importantly, interviewees felt that journaling provided structure and motivation to help them adhere to a diet or exercise plan.

Several drawbacks of current journaling methods emerged from the interviews. For instance, several students were not interested in the fine granularity of detail associated with keeping a journal. Of those who were interested in a finer level of detail, most found existing journal tools to be inconvenient and time consuming. Additionally, several students felt that existing systems do not adequately map the relationship between diet and exercise patterns.

Requirements Summary

Based on our interviews and research on existing systems, we decided to design a system to raise students' awareness of their diet and exercise patterns, while addressing the usability problems associated with traditional journal keeping. The main requirement for our system was to provide a combined journal for tracking both diet and exercise. In particular, the

system must allow users to visualize the relationship between diet and exercise.

From the interviews and research review, we also identified a number of usability requirements for our system. First, as new students enter college annually, the system should be easy to learn for newcomers. Second, our system must be mobile and discreet so that it can be used in both private and public spaces. Third, the system must be unobtrusive, that is, data input should require a limited amount of continuous attention. Fourth, since college students may have a limited budget and may not wish to carry additional devices, the system should integrate with devices that students already have. Finally, the system should be flexible and customizable to cater to users who only want a high-level overview of their diet and exercise habits as well as those wanting a greater level of detail.

Design Alternatives

With our system requirements in mind, we created three design alternatives. In the first design, we used a student ID card to automatically log meals purchased with the card and visits to the gym. In the second design a camera phone was used to take pictures of food and to store exercise information. The third design allowed users to keep a diet and exercise journal on an iPod and learn to use gym equipment via podcasts. All three design alternatives supported integration of diet and exercise information via a desktop system which allowed users to chart their progress.

To evaluate the design options, we participated in a one-hour poster session to receive feedback from the HCI community at Georgia Tech. At the close of the session, it was clear that the majority of the reviewers felt that the cell phone design was the best option because of the features it supported. Next, we describe prototyping and evaluating the cell phone design.

Prototype Description and Evaluation

We developed a prototype, the FotoFit system, with three components: a camera phone, an application for exercise machines in the gym, and a desktop visualization application. With this design, users take pictures of their meals, snacks, and/or beverages using their camera phone. When at the gym, users log into an exercise machine using their cellular phone number. At the end of the workout, the exercise machines then send a text message of the workout summary to the users' cell phone. Alternatively, for exercise outside of the gym (*e.g.* soccer or jogging), users can record exercises on their phone (by selecting from a list of activities or by taking a picture of the activity) or via the desktop application. The desktop application provides a visualization of diet and exercise (pictures and data are transferred from phone to desktop using a wireless protocol such as Bluetooth, or a USB cable). Users are also able to specify what foods are shown in the pictures and caloric information is then automatically calculated.

We evaluated our design in three ways: using a diary study, a think-aloud experiment and a cognitive walkthrough. In the diary study, we evaluated the viability of using a camera phone to keep a photographic food journal. 11 Georgia Tech students participated in our study: 4 students kept a food journal using a camera phone (Group 1) and 7 students kept a written food journal (Group 2). Participants were instructed to record everything they ate and drank for 5 days. At the end of 5 days, we interviewed each participant about his or her experience. Overall, Group

1 found that the camera phone food journal was useful. Group 2 often forgot to carry their paper journals around and speculated that they would have preferred the photo journal since they always have their cell phones on them. In addition, Group 1 indicated they wanted the ability to easily browse through journal entries on their phone. Group 1 also wanted ways to classify food items in terms of breakfast, lunch, and dinner and to be reminded to take pictures of what they have eaten.

After the diary study, we created a partially functional prototype for the desktop visualization application using PowerPoint and conducted cooperative think-aloud and cognitive walkthrough [4] tasks for evaluation. In the prototype, we created a 4 day diet and exercise journal for an imaginary user. The prototype provided a "day view" in which pictures of the user's food were displayed either un-annotated or with attached caloric information. In addition, a stock photographic image was displayed to represent each exercise activity that the imaginary user completed. The prototype also provided a "week view" screen in which a high-level overview of each day in one week was represented by a collage of the photographic images from that day.

The think-aloud evaluation was conducted with each of the 11 students who participated in the diary study. The results indicate that the photographic medium can be quite expressive for helping individuals reflect on their diet and exercise practices. Even though participants were interacting with the journal entries of an imaginary user, they made qualitative assessments of the imaginary user's diet and exercise choices. For example, several individuals exclaimed that the user clearly "needed to eat more green vegetables," or that he "went to the gym the next day to make up for [the poor eating habits of the] previous day". Thus, participants were able to craft a story around the photographs and make assessments and suggestions for improvement. Several subjects even said that the images were meaningful themselves, without additional detail (e.g. without specific calorie counts or graphs). In addition, participants indicated that they wanted the flexibility to visualize their diet and exercise activities in different ways (*e.g.* to compare all of the breakfasts they ate for a week or two days side by side).

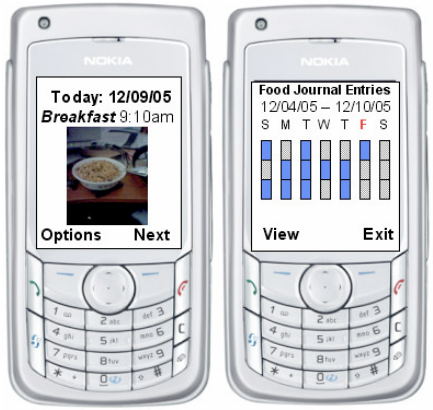
In the cognitive walkthrough, 4 HCI experts evaluated the learnability of our system by completing the same navigation tasks used in our think aloud evaluation. These experts found the system easy to learn in general, but suggested that we more clearly label different areas of the interface and indicate which parts of the screen were clickable.

Final Design

Based on the results of our evaluations, we refined the design used in our prototype to create a system that provides users with greater flexibility as they create, view, and compare journal entries. The system still consists of three components: a cell phone, an exercise machine application for the gym, and a PC visualization application that displays information gathered from the cell phone and gym equipment. Our final design provides users with the ability to gain a high-level overview of their diet and exercise habits (*e.g.* by viewing their photographic diet and exercise journals) while still supporting those individuals who wish to have a more detailed account of their activities (*e.g.* through caloric analysis). Instead of utilizing traditional text-based journaling, our system centers on the

photographic medium, which our studies show as useful for supporting reflection and assessment of diet and exercise habits. In addition, our design supports the mobile lifestyle of a college student and is relatively inexpensive because it utilizes a camera phone and a PC, two devices that many students already own and exercise machines that many college campuses provide.

FotoFit Cell Phone Application
a. The FotoFit photo gallery allows users to browse their food journal on the phone.
b. Users can see which meals they have taken pictures of. This can be useful if the user wants to see which days they forgot to eat breakfast. Each day starts off as a grey bar with three segments, the bottom corresponding to breakfast, the middle to lunch and the top to dinner. When a food entry is added, the corresponding segment of the bar is colored.



a. **b.**

Figure 2. 2 screenshots of the FotoFit cell phone interface.

To address concerns raised in the diary study, we developed a more structured application for the cell phone. Users take a photo of their food using the camera on their phone but after the picture is taken they can choose to add it to the FotoFit system under the category of breakfast, lunch, dinner, or snack. A default categorization is suggested based on the time of day, but these are customizable. Next, the user may enter the FotoFit photo browser to view the new journal entry (Figure 2). Finally, users can manually input exercise activities that were not completed at the gym and have this information automatically downloaded to the desktop visualization application. The user can add an activity by taking a photograph of the activity (*e.g.* a soccer field) or by using the cell phone keypad to select from a customizable list of common activities as well as input the duration and intensity level of the exercise.

The second component of our system is an application for exercise machines used in the gym. The application would be viewable on a flat screen display attached to the machine. When the user is prepared to use a machine, she logs into the system with her cell phone number. When her workout is complete, a summary of her activity is sent to her cell phone via SMS. When the user synchs her phone with her PC, both the food and exercise journals are downloaded to the desktop visualization application.

Finally, the visualization application allows users to reflect upon the diet and exercise activities in which they have engaged. A user can set and track goals, see the relationship between diet and exercise visually, obtain calorie counts and create notes to help build a story about her health choices. Figure 3 provides a detailed description of the application.

Conclusion

Raising awareness of health concerns among college students may spur students to take an active interest in developing and maintaining healthy lifestyle habits. Our system is designed to support the tracking of both diet and exercise activity and most importantly, to help users visualize the relationship between diet and exercise through use of the photographic medium.

FotoFit Desktop Visualization
This screenshot shows the user's diet and exercise activity for Monday, December 12, 2005.
a. The toolbar at the top allows users to add or delete diet and exercise entries. Users can also create or edit daily diet and exercise goals (described further in 'h').
b. Users can navigate through their journal day by day using the calendar or view several days at once (not shown in this screenshot).
c. Users can upload a picture of themselves or other aspects of a setting to help them create a story about a particular day. For instance, they may upload a picture of a social event to link the day's eating and exercising with "Christmas dinner". Alternatively, they may upload a picture of apples to remind them to eat more fruit.
d. Users can also add notes about a day's events.
e. This area shows the pictures of food (that have been uploaded from the cell phone) along a 24-hour timeline. Each picture displays caloric information if the user has specified what type of food is in it. In addition, if the user has associated categories with the picture (e.g. 'dairy' if the picture contains dairy products), it can be flipped to display this information as shown in the first photo. The backside of the photo allows users to edit the photo details or delete the photo. The colored circles represent the different categories of food in the photo.
f. In the bottom half of the pane, exercise photos are displayed along the timeline.
g. Two bars indicate the day's overall caloric intake and output at a glance.
h. Users can create or use existing food categories to indicate what types of food are in a picture. This area displays a summary of the different types of food that have been consumed.

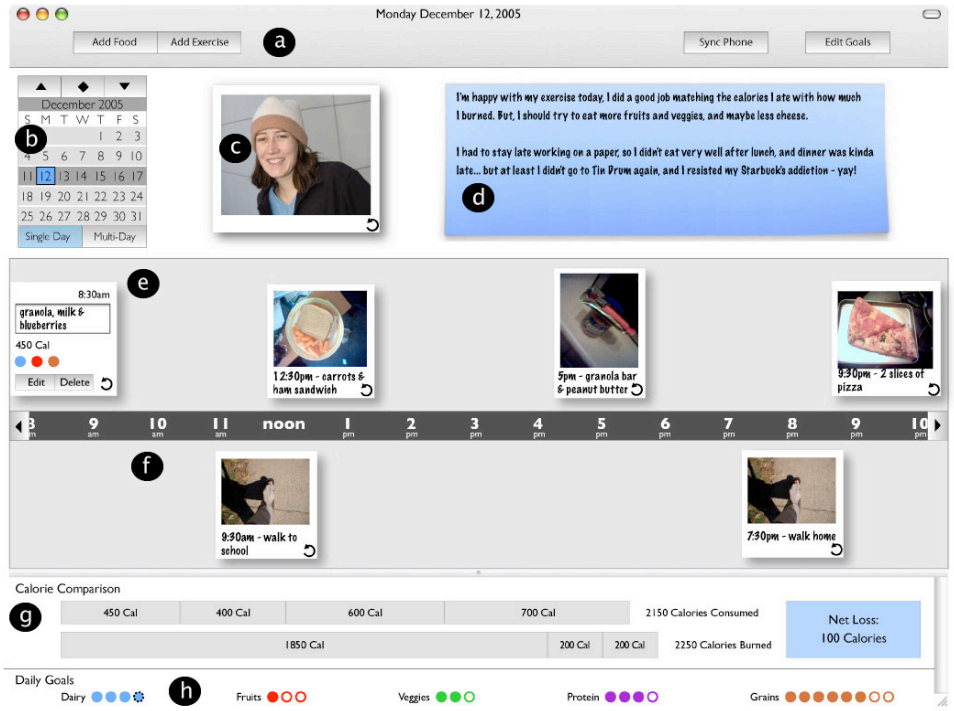


Figure 3. The FotoFit desktop visualization application.

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