
Designing for Context-Aware Health Self-Monitoring, Feedback, and Engagement

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Abstract

There is a novel opportunity to increase awareness of health activities in a person's daily life. One way to do that is through context-aware self-monitoring. We explore design insights from field work and field testing different methods for self-monitoring. We present an innovative design for establishing context-aware self-monitoring that has the potential to improve health.

Keywords

Context-aware, Design, Mobile Health, Persuasive Technology, Self-monitoring

ACM Classification Keywords

H.5.2. User Interfaces. User-centered Design

General Terms

Design, Human Factors

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INTRODUCTION

Persuasive technologies show promise to promote physical wellness [2 4 5 8]. Crum and Langer [1] demonstrate how awareness of exercise benefits of everyday activities can yield dramatic health effects without behavior change. In other words, recognizing healthful intent in everyday activities can affect health. Mobile persuasive design (e.g., text messaging & phone calls) presents a unique space for "hot triggers" to change, reinforce, and reward behaviors in context [9]. Our research focuses on the design of a mobile application for engaging health-interested individuals through context-aware self-monitoring and goal-relevant messages. We use the term context to represent the mobile sensing of location and time. To the best of our knowledge, the use of context-aware self-monitoring with tailored feedback is under-studied.

Personas

Our application design is for *health-interested but inactive individuals* (i.e., someone desiring to be healthy but lacks a set routine of physical activity). We utilized *fitness-active individuals* (i.e., someone who routinely exercises on a weekly basis) as models.

CONTEXT-AWARE HEALTH ENGAGEMENT

Text messaging has been shown useful for promoting health behaviors via the presentation of time-relevant information [5 8]. Further, a self-monitoring application for happiness was useful for reducing stress [7].

Combining self-monitoring with context-aware health messaging for awareness has not been explored. Using a technique from [10] for sensing locations, we propose designing an application that increases awareness of opportunities for “physical activity” in a person’s context and daily routine and for increasing mindfulness of activities that individuals already engage in that may confer health benefits [1]. While mobile activity-sensing [2] has proved successful in capturing general physical activity, the application relies on self-report for several activities (e.g., yoga & swimming), which are difficult to assess passively [2]. This suggests that while mobile activity-sensing is well suited for quantifying time spent in different physical activities, it must be accompanied with self-monitoring to capture some behaviors. Further, self-monitoring is vital to assess the purpose and context for the behavior; a key design element for goal-setting. Opportunity for behavior change comes from context-aware self-monitoring that increases awareness of health & purpose within activities. To explore this, we conducted field studies of self-monitoring techniques.

FIELD WORK

We interviewed individuals from three domains to gain perspectives and insight on their fitness processes.

Long-term Wii Fit Users

We interviewed Wii Fit players to understand their motivation and difficulties with fitness game. In these games, users engage in yoga and other exercises and also perform a health each week. We conducted a guided walk-through with two female professionals. Both were yoga enthusiasts and had played the system for more than nine months. They both loved the novelty, playfulness, and being active through a game;

however, over time they both became inactive. Subject A reached a *plateau for high scores on yoga and did not receive further feedback for improving*. Both subjects played with their families but subject B emphasized that *health (weight) and fitness (frequency of activity) are very personal*. Although she felt comfortable sharing this information with her family, She did not want to share with her friends. In addition, both subjects expressed discouragement when they saw a calendar of how much they had *not* exercised.

Health Fitness Coaches

We interviewed three coaches to learn how they motivated clients. Subject F & G were fitness coaches in a corporate gym and large urban gym, respectively. Subject H was a swimming coach. Two of the coaches kept detailed records of their clients’ fitness records but never showed this information to the clients because they thought *the level of detail* was unnecessary for the clients. Coach G adjusted plans based on monthly evaluations of all fitness measurements The coaches capitalized on their client’s feeling of guilt if they did not meet goals to motivate sustained behaviors.

Student-Athletes from Beijing Sport University (BSU)

Three students from BSU were interviewed who excelled in various organized sports prior to university and were enrolled in China’s premier school for athletics. All three exercised regularly. Subject C, a former weightlifter, stated that physical activity is a habit that is difficult to start and to maintain. He explained that *setting goals and adjusting plans is crucial to performance and wellness*. All stated their coaches *tailored feedback* for their performances based on detailed discussions rather than measurements only. For example, Subject D, a university runner, would not

Table 1. User Centered Field Testing

| # | n | Analysis Performed |
|---|----|--|
| 1 | 15 | Contextual interview of one week usage of a structured journal for qualitative physical activity information |
| 2 | 10 | Contextual interview of one week usage of input form and recording of physical activity after exercising |
| 3 | 8 | Lab-study of effective representation for the past week’s physical activities |

| EXERCISE | | Friday | Saturday |
|--------------|--|--------|--|
| Exercise | | | lifting running |
| Strength | | | running for 10 min lifting for 40 min |
| Rating | | | easy |
| Other/Detail | | | I feel happy and exhausted. |

Figure 1. Picture of a fitness-active participant's journal from Field Test 1. He has given qualitative data.

Activity Log

Record your physical activities in the form below. Please keep this prototype with mobile phone for the next week.

When did your activity happen?

Time: 3:30 Pm Date: 11.13 Location: BUAA GYM

Duration: 60 minutes
Eg. 30 minutes

Details: Running for 10 min
60 sit-up
weight training
and strength training
for 40 min.

Write exercise name, performance, etc...
I ran 10 km with Joe, and I need to stretch my legs before running.

Figure 2. Structured input for the same participant from Field Test 2. (This part is out of printing area, please revise)

be chastised for a weak lap time if external circumstances caused it. In addition, the coach would *provide advice on how to overcome plateaus*.

FIELD TESTING

Our field testing explored users' reactions to self-monitoring and suggested health-interested and fitness-active persons had different needs (Table 1).

Tabular Health Self-monitoring (Field Test 1)

Based upon the journals used by fitness coaches, we designed a paper table for 15 participants to record physical activities for a week. It had the following prompts for each day: 1) Exercise, 2) Rating, 3) Strength, and 4) Detail. The form was intentionally ambiguous. None had health journaling experience. Participants completed an online survey and were later interviewed. We labeled participants according to their habits / responses: 8 health-interested and 7 fitness-active. Subsequent studies used subsets of these participants. All participants expressed difficulty quantifying their physical activity and strength. 7 participants included qualitative answers for Rating ("!x1000"), strength ("Medium" or "^_^"), or Detail ("Just for relax[ing]").

Mobile Health Self-monitoring (Field Test 2)

We designed another form that participants carried with their mobile phones for ad-hoc self-monitoring over the course of a week. 10 individuals were selected from the previous study. We conducted interviews to understand usage and value gained. Each input fields (Date, Duration, and Details) contained an example response. The prompt for duration decreased the qualitative detail we received, suggesting that, if seeking information about purpose of activities, the

inclusion of duration—a key factor that can be measured well passively—may be a hindrance to promoting awareness of the positive health impact of everyday tasks. The detail priming consisted of exercise naming, with whom, and distance. 3 participants gave qualitative responses about the impact of physical activity on mood, a key secondary benefit of physical activity. Overall, participants responded well to priming (all recorded exercises in detail). 8 responded the smaller form increased awareness of health by helping record their habit since it was nearby.

Mobile Weekly View Comprehension (Field Test 3)

To study the insights learned from scanning a week of exercise, we created three medium fidelity physical activity representations. The screens all contained a visualization of an activity log for the past week followed by a table encoding the same information. In a lab study, we asked 8 (from the previous study) participants to think-aloud as they reviewed each mobile screen and interpreted "their" physical activities. Almost all health-interested said seeing total time and number of exercise sessions over the past week helped frame how active they were. Of these, three wanted a reference to a standard "health" metric for the appropriateness of goals. In contrast, fitness-active exercisers were interested in exercise referenced to previous patterns.

KEY DESIGN ELEMENTS

Based on the previous work and our field testing, we are developing an application with the following key design elements: a) promotes increased awareness of physical activity within context through self-monitoring; b) does not establish a "ceiling" for achievement that may reduce long-term motivation for behavior change;

c) flexible in design to accommodate days when activity was not accomplished, with particular focus on highlighting accomplishments rather than set-backs; d) establishes goals, with reference to health benefits and recommendations for physical activity.

In our design, we harness the power of self-monitoring to increase awareness only during appropriate times of the day and in appropriate locations to reduce annoyance and improve retention. In addition, our application promotes both broad goals ("Engage in moderate-intensity physical activity for 150 minutes per week") and specific goals that can be maintained as part of a person's daily routine ("Park 10 minutes farther away at work"). These small but meaningful and concrete tasks are vital to increasing awareness of opportunities to engage in physical activity within a person's routine. After user-defined goal-setting, we provide feedback in a context-aware way (e.g., prompt after at the start of normal business hours to confirm engagement). Similar to [7]'s study on happiness, we designed for the self-monitoring of purpose to engage the user in recognizing health benefits in activities they are already engaging in (e.g. when a person takes a break from sitting, highlight standing up and moving around is healthy). Finally, we integrate a playful fitness companion in the form of a dog avatar to present aforementioned feedback on fitness goals in an emotional aesthetic to the application [4].

CONCLUSION AND FUTURE WORK

Our work supported our intuitions that context-aware self-monitoring may be a fruitful pathway for increasing physical activity. Future work includes building our system to understand user behavior and health benefit, as well as the value gained from sharing fitness data.

As one Wii Fit user pointed out, health data is personal and sharing this data within user social groups may not be appropriate for all participants. Further, social motivations may have unintended negative consequences depending who is in a person's social network. Based on this, we plan to explore the power of social networks within our group but are mindful that it may result in unintended consequences.

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