MobileHealth: Delivering Context-Appropriate Advice for Weight Management

Abstract
In this paper, we present a study of MobileHealth, a mobile phone application for delivering context-appropriate advice for weight management. MobileHealth allows users to monitor and track their dietary and exercise behavior by recording foods eaten and exercises performed on their mobile phones. The study compared the effect of delivering context-appropriate health advice over time to the same advice delivered all at once. Although this study failed to show a benefit of context-appropriate messages over time, we found interesting indications of the importance of well-organized information.

Keywords
Health, obesity, weight management, education, ubiquitous computing, behavior intervention.

ACM Classification Keywords
H5.2. Information interfaces and presentation (e.g., HCI): User Interfaces; J.3. Life and Medical Sciences.

Introduction
The obesity epidemic in the United States has made educational information on diet and exercise pervasive in the media: according to the International Food Information Council Foundation and the Center of Media and Public Affairs, educational information on proper eating and exercise has emerged as the single most
important focus of media reports about nutrition and food safety since 1995 [4].

Despite the media attention, however, the effectiveness of the advice conveyed by the media has been questionable due to a consistent lack of context. An article in Food Insight Journal reports [3],

"Journalists are very good at telling 'what' of a food and health story, but can leave off 'to whom' does the advice apply, 'how much' is needed, 'how often' should the advice be followed, and 'what are the consequences' of the following advice. [This often brings] about a situation in which consumers cannot judge the relevance of the information to their own diet, lifestyle and nutritional needs."

Receiving accurate preventive health information on eating and exercise that is situated in one’s lifestyle and needs is difficult. Programs that provide professional one-on-one counseling in nutrition and exercise are costly and require major time and schedule commitments. Although they may be an effective solution for those who can afford the expenses and the time, most overweight Americans do not fit this socioeconomic bracket or are unwilling to make the necessary time commitments.

A compelling method for educating people on weight management is to leverage the mobile phone platform for tracking calorie intake and delivering tailored advice based on their context. The benefits are two-fold: first, the computational power of smart phones affords the ability to automatically find patterns by analyzing the data collected from self-monitoring in real-time. Based on the findings, highly-tailored preventive health advice can be delivered to the user. Second, the always-carried and always-on nature of mobile phones allows tailored preventive health advice to be linked with the behavior at the time and place that it occurs.

Functioning as omnipresent virtual health fitness trainers, this can help users make informed decisions on food and activity choices in situ.

Yet, the feasibility of using mobile phones as a platform for delivering health advice is uncertain. Among other claims to be examined is the issue of context-appropriate health advice. Does delivering tailored health advice at relevant times help users learn more effectively about weight management? Studies suggest that users will learn more when a connection is formed between the advice and the conditions under which it applies [1].

To explore these issues, we designed and developed MobileHealth, an application for mobile phones that allows users to track their eating and exercise habits while receiving context-appropriate advice. We conducted an eight participant user study that compared the effect of delivering context-appropriate health advice over time to the same advice delivered all at once. The study failed to show a benefit of context-appropriate messages over time, indicating instead the importance of well-organized information.

The rest of the paper is organized as follows. First, we discuss related work on appropriating ubiquitous technologies for health. Then we describe a usage scenario that motivated MobileHealth. Afterwards we give a description of the prototype, and our evaluation.
We conclude with a discussion of our results and further work.

Related Work
While there are a number of calorie tracking applications designed for the Personal Digital Assistant (PDA) platform, only a few exist for the mobile phone platform. Out of these, none that we know of focus on delivering context-appropriate advice tailored to the individual. Ubifit, for example, is an application for mobile phones that allows users to monitor their step count in social groups [2]. Consolvo et. al. found that by broadcasting one’s step count to friends and family, the user was more motivated to increase their amount of walking throughout their daily life.

On the PDA side, two applications stand out as most relevant. Diet and Exercise Assistant is a commercially-available PDA application that helps users track their calories, but no literature exists on it that we know of [5]. Also, Intille et. al. report on a prototype of a PDA application that aims to encourage better dietary decision making through just-in-time motivation at the point of food purchase [6].

Usage Scenario
The design of the MobileHealth system was motivated by two main usage scenarios. First, we wanted users to be able to effortlessly enter and view calorie intake and expenditure data on their mobile phones throughout their daily lives. Second, we wanted to allow for health counselors and primary health care providers to remotely monitor the progress of patients using MobileHealth through a web-based interface, and to deliver tailored advice to the individual via SMS to their phones.

The client application is the primary way the user interacts with the MobileHealth system. The server application has three primary functions: to send reminder messages to the clients to update caloric information, to store the food and activity database, and to keep a record of the users’ daily calorie data. This delocalized approach to saving data on a separate location allows for more reliable data storage (due to the risk of the cell phone errors) and more sophisticated methods for displaying and analyzing of data than the phone can support. Currently, a web-based interface for analyzing the data on the PACE server doesn’t exist, and we therefore leave it out as future work.

Study Design
We conducted an exploratory user study with MobileHealth over ten days. Eight participants were gathered from friends and family. Participants ranged from 23 to 66 in age. Two were male and six were female.
Hypothesis. Our hypothesis was that users would be more receptive to health advice if it is delivered in small, relevant doses, based on the theory that users will form a stronger connection between the recommended action and the conditions under which it applies.

In order to test for this hypothesis, we created a one page passage on Resting Metabolic Rate (RMR) and its relevance to weight management. An example portion of the passage is:

Another way to keep the RMR higher is to eat more frequently. Burning calories by eating is called the thermic effect of food. Eating regularly (every 3 hours at the least) maximizes the amount of energy burned by consuming and digesting food. Waiting too long between meals will signal the body to become more efficient on fewer calories, lowering the RMR.

We then took the participants through three stages:

Participant Intake. We first gave them a pretest to elicit background information (such as cell phone and technology usage habits, weight goals, current weight management techniques, etc). The pretest also included a calorie estimation test in which we asked them to estimate the amount of calories contained in five different types of foods (shown as pictures). This test was used to gauge how well they already were at estimating calories. We then set them up with a Motorola RAZR with the MobileHealth application pre-installed, to use for ten days.

Participant Exit Interview. After their trial was over, we conducted an exit interview in which we first asked the control group to read the RMR passage. We asked all participants for application and experience feedback. We then tested the participants again on calorie estimation to see whether their ability to estimate calories improved after the trial. Then we gave them a set of ten fact and inference based questions from the passage to measure how much they learned. No feedback was given to the users on their answers. Passage-based questions were scored on 0-2 scale, 0 being incorrect/missing, 1 being incomplete, and 2 being complete and correct.

Example questions read:

[Fact] What is “the thermic effect of food”?

[Inference] How does eating breakfast within an hour of waking encourage weight loss?

Delayed Posttest. Approximately a week after the trial, we again asked all participants to answer questions based on the passage to measure how much knowledge they retained over a period of a week.

Key Findings

Context-Aware Delivery. This study failed to show a benefit of context-appropriate “Just-in-time (JIT)” messages. There was a difference between the groups, however, it was users who received the comprehensive “Passage” at the end of the study who scored higher on the post-test than those who received the passage in portions throughout their trial. (Figure 3)
Because we were concerned that this finding was the result of the Passage group having read the information more recently, we then looked at the results of the second post-test. Interestingly, both groups scored better over one week later, with the JIT group showing a significant gain in scores.

We had not expected participants to score better after a delay, so we decided to look more carefully at the questions to see what might be driving this effect. Separating the fact-based questions from those that required inferences based on the passage, we found that the lower scores on the first post-test were derived primarily from the JIT participants’ poor results on the inference-based questions. Their scores on the second post-test were high for both fact-based and inference-based questions.

Why the JIT group would show this increase remains a mystery. One plausible explanation would be an “unfinished task” effect created by the questions of the first post-test, which remained unanswered [7].

Caveats. The study is not without several caveats that complicate our results. These include:

- We have no way to tell if, and how much, the participants’ attitudes toward technology, motivation, and commitment to learning affected their experience with MobileHealth. Because we saw high variability in participants’ motivation and commitment to learning, it is difficult to generalize across the participants.

- We had to disqualify one participant in the experimental (just-in-time) group because we...
determined at pre-test that he was already an expert in weight management, and thus had little to gain from the messages. Another participant could not complete the post-test due to personal issues. The experimental group was therefore reduced from four to two participants.

• Messages we sent to the JIT group were delivered by email. There may have been issues with spam, length of the messages, or the fact that it's not in-situ that may have affected their learning.

• Passages also may have been too generic. Participants reported low applicability to input to their lives. The delivery of passages to the JIT group were delayed by at least 24 hours relative to their input due to the upload lag.

• The trial was conducted during Thanksgiving holiday, which is not a typical week for weight management.

Conclusion and Future Work
There appears to be value in seeing a “comprehensive” overview passage rather than short messages over time. We suspect that the well-organized passage gives users a better sense of the underlying mechanisms regulating calorie consumption. Therefore it would be interesting to explore further the advantages associated with organized information received at optimal intervals, as well as message length and delivery methods. Work is needed to examine how to better tailor health advice to the user. We look forward to a longer user study, focusing on motivated participants who have the most to learn from the MobileHealth system.

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References


