A Novel Way to Conduct Human Studies and Do Some Good

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CHI 2010, April 10 – 15, 2010, Atlanta, GA, USA.
ACM 978-1-60558-930-5/10/04.

Abstract
In this paper the authors describe a novel way to conduct large-scale human studies achieving the maximum outreach and impact with the minimum cost. An iPhone health application, `Walk n' Play', was developed and released for free in the App Store. The application measures calories spent due to walking activities through the iPhone's accelerometer. It is a real-time awareness tool that helps people to keep their sedentariness in check. Furthermore, it uses motivational mechanisms based on buddy support/competition and social networking to increase daily physical activity. The anonymous data gathered from thousands of users around the world, reveal patterns of human behavior at a resolution and scale not feasible before.

Keywords
Human studies, physical activity, iPhone applications

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous

General Terms
Design, Experimentation, Human Factors, Measurement

Introduction

The authors have developed an iPhone health and fitness application called `Walk n' Play' [8]. The software is distributed through the App Store for free [6]. The application translates walking activity to calories spent, helping the user to keep tabs of his/her daily physical activity levels. The user can set goals, which the application helps him/her to attain or exceed through buddy and social networking mechanisms. The most important mechanism, however, is the real-time information that the application provides. Modern humans do not often realize how sedentary they are. In a prime example, a user in this study had the habit of asking her son to bring her water. When she realized through the application that by making the short trip to fill her own glass she could burn a few calories, she changed this habit.

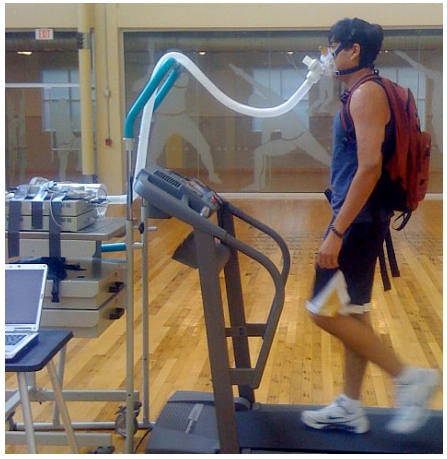

Figure 1. In lab indirect calorimetry experiment.

An early work that bears some similarities to the present effort was reported in [7]. They are both situated in the general area of persuasive technology [2]. Nowadays, fitness applications, like Nike+ and RunKeeper, flourish and proliferate; they are mostly targeting motivated runners. Walk n' Play appeals to a broader demographic, that is, people who simply want to become less sedentary.

Walk n' Play is an outgrowth of a research effort that lasted for almost two years [3][4] and aimed to bring metabolic measurements from the lab to the `street'. The gold standard of metabolic measurements remains the indirect calorimetry employing respiratory gas analysis. This is an obtrusive measurement that usually happens in the lab for a limited amount of time (Figure 1). The problem is that metabolic activities, such as walking, happen throughout the day and outside the lab. Thus, a method was needed to perform such measurements unobtrusively and continuously. This would provide the basis for a sound monitoring and intervention program.

Accelerometers could serve as alternatives to metabolic calorimetry, if properly calibrated [1][5]. They are small in size and can be attached to a part of the body, thus untethering the subject from the lab setting. Ideally, these sensor data need to be processed real-time and then sent to a server location for central access. Cell phones became small computers that people carry with them all the time. Thus, they became the natural platform for handling accelerometer data.

Initially, cell phones did not feature embedded accelerometers and the user had to carry both the cell phone and a separate accelerometer box. With the advent of iPhone this has changed. Users now need to carry just the cell phone (which they do anyway), with obvious gains in usability. Energy draining and communication failures due to the past phone-accelerometer Bluetooth connection have been eliminated, which improved reliability.

The single most important development, however, happened in the way one can now distribute such applications, that is, through the portal called App Store. There are two big problems when it comes to physical activity research: First, develop an unobtrusive system that can accurately measure physical activity throughout the day. Second, administer large-scale longitudinal experiments to understand the patterns and design and test appropriate interventions.

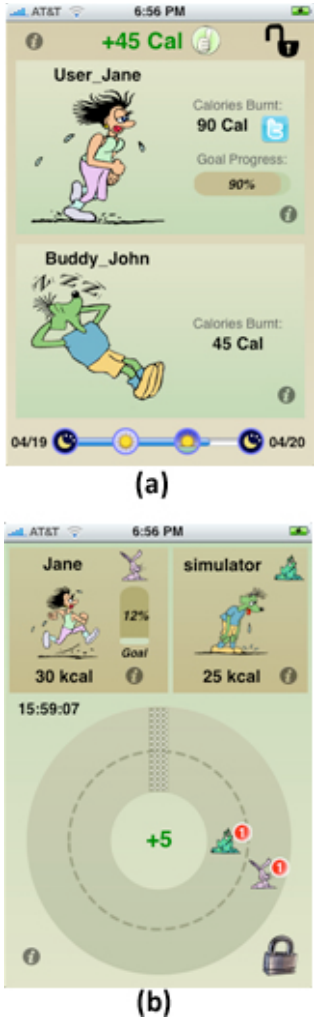

Figure 2. (a) Current Walk n' Play interface (b) Initial Walk n' Play interface

The first problem was solved with the advent of iPhone. The second problem is likely to be solved with distribution mechanisms, such as the App Store. It is characteristic that in the NEAT-o-Games research [3][4] that predated Walk n' Play, a handful of volunteer users from the local community were recruited at great expense and effort; monitoring periods over a month or two were almost prohibitive.

Since the release of Walk n' Play in the App Store in April 2009, thousands of users without any solicitation took to the application. They are from all over the world offering a substantial and representative sample of humanity. Their anonymous physical activity data are being recorded on the server month after month, offering a longitudinal horizon that a small lab would not be able to afford otherwise.

In the remainder of the paper, first, we briefly describe the application itself and some lessons learned from user feedback. Then, we describe initial results that offer a peek into patterns of human physical activity and adaptation. A discussion follows on the intervention possibilities that such a deep look can spawn. This concludes the paper and makes the case for a new methodology in human studies that may revolutionize certain fields.

The Application

The application measures physical activity due to walking, when it is on. It communicates this to the user through animation. When the user walks, the animated avatar that represents him/her in the application walks as well and the calorie tally is updated real-time. When the user does not move, then his/her avatar falls asleep.

There is a control entity that aims to keep the user `honest'. This is either a buddy or a simulated entity and is represented by an animated avatar, too. The real-time animated information acts as a high-impact awareness tool; it vividly conveys how sedentary one is with respect to himself/herself and the `competition'.

The user may choose to tweet his/her achievements by tapping on the Twitter button. The metabolic count is reset to zero every 24 hours, for the next day. A graphical timeline at the bottom of the screen situates the user with respect to the diurnal cycle. The application makes use of the proximity sensor and automatically switches off the screen once the phone is put into the pocket or bag, to conserve energy. A History screen can be accessed through the menu and offers a comprehensive view on past performance.

Simplicity is the hallmark of the user interface (Figure 2 (a)). It was not always like this. Early interfaces were much more complicated with unnecessary elements, which were not well received by the users (Figure 2 (b)). Their message was: `We want a simple, clean-cut interface that can vividly convey in a second or two what is going on'.

Results and Discussion

Since April 1, 2009, there have been over 8,000 user enrollments out of which over 6,000 remain valid and active. Overwhelmingly, these users come from North America and Europe. The distribution of their Body Mass Index (BMI) is shown in Figure 3. It appears that there is a good mix of people with normal BMI along with overweight and obese individuals.

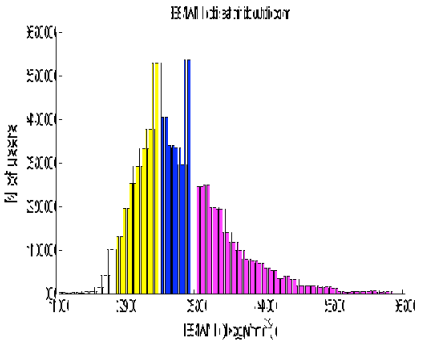

Figure 3. BMI distribution of all valid Walk n' Play users as of August-31, 2009. Yellow is normal, blue is overweight, and magenta is obese.

Figure 4 shows the distribution of calorie expenditure in weekdays and weekends over the five month period that Walk n' Play is in the App Store. The graphs show persistent use of the application throughout the performance period. A fascinating observation is that in weekdays, activity peaks are observed twice: between 6-8 am and around 8 pm (horizontal white bands). This is presumably before people go to work and after dinner. In the weekends there is a much more scattered distribution.

Based on these results, researchers can start designing interventions that either further intensify the structured activities before/after work that already exist or create a third structured activity zone around lunch time. Using the methodology proposed in this paper, the researchers can measure the impact of their interventions getting large-scale longitudinal data at minimal expense, while doing some good to humanity.

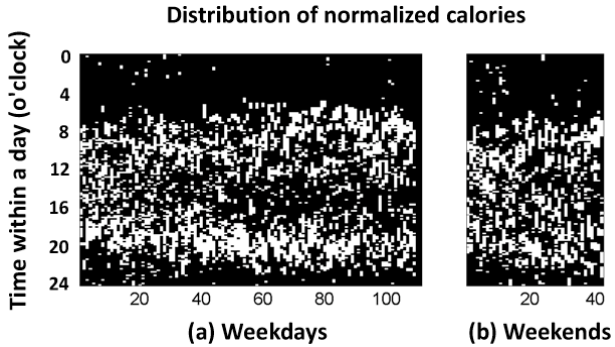

Figure 4. Distribution of physical activity over weekdays and weekends throughout the performance period.

Acknowledgements

This research was funded in part from the Eckhard-Pfeiffer Fund of Prof. Pavlidis.

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