# Fitbit+: A behavior-based intervention system to reduce sedentary behavior

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***Abstract*—Self-tracking wearable devices are capable of tracking calorie consumption and inferring physical activity physical activity to support self-awareness and healthy behavior. These devices automatically capture human behavior (such as walking) but do not typically make the user aware detected unhealthy behaviors . Furthermore, these devices cannot intervene in the moment to make users aware they are engaging in unhealthy behavior (such as sitting for a long period of time) and persuade them to correct these unhealthy behaviors (e.g., by taking a break to go for a walk). There is an increasing trend for people with low physical activity occupations to sit for long periods of time, yet research suggests that lengthy sitting, independent of overall physical activity level, increases the risk of weight gain and mortality [1] . We aim to decrease the duration of sedentary bouts in the workplace by detecting when people have been inactive for a long time and then prompting them take a short break from their desks. In this poster we present the design of Fitbit+, a system that realizes this strategy by leveraging Fitbit's near real-time, automated step logging to detect sedentary behavior and then prompt users to take short breaks.**

## I. Introduction

Currently, there is an obesity crisis affecting the United States and other developed nations. A possible cause of this crisis is the increasingly sedentary lifestyle, especially during working hours. During working hours, people tend to sit between 4.5 to 9 hours [2], [3]. Sedentary behavior has a negative impact on both short-term and long-term health. Some of the consequences are increased risk of weight gain, metabolic disruption, and premature mortality [4]. On an encouraging note, there is a growing body of research suggesting that breaking up sedentary periods with short periods of physical activity has a positive effect on health [1]. Our poster presents a systems that seeks to shorten sedentary bouts at work by creating a systems that makes people aware in the moment of the undesired behavior in a non-disruptive manner.

In response to the obesity crisis, an array of health and fitness devices are being created. Their goal is to encourage healthy behaviors by supporting self-monitoring and self-awareness with respect to nutrition and fitness. One of these devices is Fitbit[1]. This device detects and stores steps taken, intensity of physical activity, duration of activity , distance travelled, and estimated caloric expenditure. This data is relayed to the user in two ways. The first, is through the device's screen which gives displays current state of activity, calories, and steps. The second through a website in the way of charts and graphs not only the current date but also summarizing past days.

The following scenario expands on the use of Fitbit: *Joe is concerned that he is not active enough. He likes using Fitbit because it is not intrusive, it has a long battery life, and it counts his steps automatically and accurately. Joe enjoys getting immediate feedback on his activities, and viewing his activity log history, and tracking progress toward his goals online. He also enjoys how his data is automatically uploaded when the Fitbit is in close proximity of its base station even when he is wearing it.*

*Fitbit helped Joe become aware of how little he walks on a regular basis, which he attributes the innumerable hours he spends sitting at work. He decides to make an effort to walk more and sets himself the goal of walking 10,000 steps a day. However, in the first week of trying to reach his daily goal, he struggles. He is busy at work and finds it difficult to remember to take walking breaks regularly. Typically, when he gets home from work, he is still short by 5000 steps. Sometimes he makes an effort to go for a walk to reach his goal, but often he gives up frustrated.*

As the scenario reflects, Fitbit alleviates the burden of self-reporting by automatically tracking a person's daily step count. However, it cannot intervene to remind Joe he has been sitting for too long and should take a short walking break. We see an opportunity to create an in-situ behavior-change intervention by extending this self-tracking device. Our system, Fitbit+ seeks to close the feedback loop by detecting prolonged sedentary bouts and making users aware of such behavior through a non disruptive messaging mechanism. The strength for Fitbit+ is a contextually based intervention system. Fitbit+ is able to analyze user's data every 15 minutes, and from there decide if the user has been sitting for too long and if so, what type of message should be sent to the user.

[1] www.fitbit.com

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## II. FITBIT+: A BEHAVIOR-BASED INTERVENTION SYSTEM

We aim to persuade users to increase the frequency of breaks from sitting, and increase, as a side effect, their daily step counts. We hypothesize this can be achieved by prompting users with behavior-based in-situ persuasive messages. We present the design of our system, which analyzes data from a Fitbit device and prompts users to take walking breaks if they have been inactive for lengthy periods of time.

In our system, users wear a Fitbit device, which automatically transmits data in near-real-time to a base station connected to their work computers. Additionally, our system has two primary components: a recognizer and a notifier. The recognizer regularly polls and analyzes users' Fitbit data to detect periods of inactivity. When such a period is detected, the notifier, implemented with Growl[2], displays a message to the user on his/her workstation to encourage him/her to take a break from sitting. The following figure is a prototype example of our messages, Figure 1. These messages would appear on a corner of the user's screen and slowly disappear without interrupting the user's current work flow.

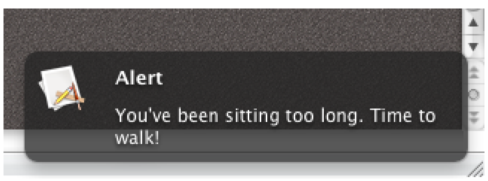


Fig. 1. Prototype of message

The design of Fitbit+'s user interface is intended to support awareness without being overly disruptive. Notification messages are displayed in a small window on the corner of the user's computer monitor, leveraging the fact that users are likely to be looking at their monitor as they work. Users can glance at a message, and quickly decide whether or not to act on it, with minimal disruption to his/her work.

We are currently exploring the use of four different message strategies for encouraging users to take breaks and walk away from their desks: *action* (*specific* and *vague*), *reminders* (*positive* and *negative*) and *feedback*. A *specific action* message is a short prompt to engage in a specific physical activity (e.g. *Thirsty? Go grab a quick drink from the nearest water fountain*). *Vague action* messages will prompt users to get up and move without suggesting specific activities. The *negative reminder* messages will mention the negative consequences of prolonged sedentary behavior, and *positive reminders* will mention the positive consequences of doing some activity (e.g *Moving helps with creativity. Take a short walk around the office to help yourself solve a difficult problem*). We would also like to explore the use of informative *feedback* to support users awareness of their activities (e.g. *You've taken 5 breaks today! Keep up the good work!*)

The following second scenario demonstrates how we foresee our intervention system being used. *Joe installs Fitbit+, to remind him to take regular breaks. During his busy workday he notices a message in the corner of his screen reminding him to walk, so he takes a walk back and forth in his hallway. He's relived he didn't have to remember to take a break in addition to keeping track of all the other tasks he has to track of at work! Fitbit+ detects that Joe acted on the prompt and does not send another prompt until another long sitting bout is detected.*

*Joe had a hearty meal for lunch, and feels lethargic afterwards. He loses track of how long he has been sitting until Fitbit+ makes him aware of it, and this time he decides to ignore the reminder to walk. Fifteen minutes later, he receives a second reminder message, which says that walking will reenergize him, and he walks around his office for 5 minutes. Notifications show up a few more times before the end of his work day and he acts on the majority of them. At the of the day, Joe glances at his Fitbit and notices that his total step count significantly increased compared to before he was using the notification system, he feels encouraged! He thinks to himself that he will make an effort to walk a little more the next time he is prompted.*

Fitbit+ aims to improve over previous methods for reducing sedentary behavior by closing the feedback loop. Prior approaches typically suggest changes to the work environment, e.g. by introducing standing desks or under-desk pedaling devices, which may not be used consistently and may be impractical for some [5], [6]. Our system instead leverages near real-time information about users' behavior to provide in-situ feedback, interceding to prompt change at the moment when sedentary behavior is occurring. This approach precludes the need for users to explicitly seek out information on the Fitbit device or website and the need for changes to the workplace environment. Furthermore, it alleviates the mental load of having to keep track how long they have been sitting for or not.

## III. PROPOSED STUDY

As mentioned previously, we have developed categories of messages that we believe will be effective for prompting behavior change. We feel it is important to further develop and test the messaging content by including members of the population of interest: people with sedentary work styles. In order to do this we are proposing a three-phase study.

**Phase 1**: Run a focus group to discuss prototype versions of Fitbit+. Brainstorm on the messages' body, what makes them effective, and persuasive.

**Phase 2**: Run a small pilot study integrating the feedback from the previous stage to test the content of the messages, the timing of the messages, and the system overall.

**Phase 3**: Finally, after integrating into Fitbit+ the feedback from the previous phases we plan to run a randomized controlled study to test our hypothesis with approximately $n$ = 28-30 who are currently Fitbit users.

[2]http://growl.info/

In this study half of the participants will use Fitbit+ and have of them will continue to use the Fitbit device as usual. We will evaluate the effectiveness of Fitbit+ by comparing the Fitbit+ users against the control group that were not given Fitbit+.

At the conference we will presenting results from phase 1 and preliminary results from phase 2.

## IV. Related Work

Our project overlaps mainly with two areas. The first is the area of interruption, specifically in the workplace. The second is the design space of persuasive health and enabling behavior change using technology.

The topic of interruption has been thoroughly discussed in the psychology space and serves us as formative work. The work done by Gillie*et. al* [7] focuses specifically at the effects of different types of interruptions on computer-based tasks. From her work we learned that if the interruption is not a heavy cognitive load, regardless of its length, it does not disrupt the performance of the main task. This relates to Fitbit+ in that we can create non-disruptive action messages and not interrupt users' workflow, regardless if he follows the recommendation to take a walking break or not.

Furthermore, the work done by Adamczyk *et. al* [8] states that a system could enable a user to maintain a high level of awareness while mitigating the disruptive effects of interruption. This correlates with one of Fitbit+'s goals, that is, to create awareness of the length of the sedentary bout in real-time. Not only that, but to create this awareness while seaming as nondisruptive as possible.

The second design space which our work falls into, persuasive health, Consolvo's work stands out as a theoretical framework to built upon. Consolvo states that for a system to be effective in creating behavior change it must have the following properties: abstract & reflective, unobstrusive, and positive [9]. Fitbit+ follows this principles by using Growl to create unobstrusive, positive, and reflective messages.

There are two systems that have similar goals to Fitbit+ that we would like to point out. The first is *Breakaway*. This system used a small sculpture placed on users' desk to make the users aware they were sitting for too long. The sculpture slouched if the user was sitting for a long time. Once the user stood up to walk then the sculpture would return to its straight position [10]. *Breakaway* uses information from sensors placed on users' office chair to communicate in a non-obtrusive manner how long the user has been sitting. Unfortunately, the system was only evaluated with a single user for a period of two weeks, and only anecdotal results were reported.

The second system is *SuperBreak*. This is a break- reminder package that provides hands-free interactions during breaks, with the goal of encouraging users to take more breaks and enhancing the benefits of those breaks. *SuperBreak* monitors keyboard and mouse activity so that naturally occurring breaks are taken into account [11]. In other words, if a 30- second micro-break is scheduled to occur every 5 minutes, it will only be suggested if there is activity at the keyboard or mouse for 5 minutes without any pauses longer than 30 seconds. Although this system focuses on preventing repetitive strain injury, it builds upon the traditional break-reminder theme. One of *Breakaway* field study results is that the system proposed breaks at inconvenient times. For systems of this nature, the authors suggest to integrate mechanism to enhance the schedule of the breaks, to integrate models that assess the cost or annoyance associated with interruptions based on computer or sensor state. This is still an issue to be addressed in Fitbit+. We plan to look at work done by Horvitz [12], and others to find the balance between determining good times to interrupt a user and making sure that breaks are proposed even when no perfect break time occurs.

## V. Future Work

As mentioned previously, we plan to integrate what we learned from the focus group and the small pilot study into Fitbit+ to perform a one-month randomized controlled study. Our poster presents preliminary results.

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