Towards a Mobile Application to Create Sedentary Awareness

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ABSTRACT
Prolonged sitting time is a potential health risk, not only for people with an inactive lifestyle, but also for those who do meet the recommended amount of physical activity. In this paper, we evaluate SitCoach, a mobile application to nudge people from their seats. The application is targeted to office workers. SitCoach monitors physical activity and sedentary behavior to provide timely feedback by means of suggesting sitting breaks. A pilot experiment with a group of 8 users learned that the general awareness of the importance of sitting breaks is low. Combined with the belief that the ability to take sitting breaks is highly dependent on external factors, a strategy of proposing break reminders may not be the most successful for this target group. Future work should focus on raising awareness of the problem and providing insights into personal sitting behavior.

Author Keywords
Sitting time, mobile persuasion, sedentary awareness, physical activity.

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

INTRODUCTION
In the past years, a substantial amount of research has been devoted to physical activity promotion through mobile devices. Using the accelerometer embedded in a mobile phone or in a dedicated device, the energy expenditure of the user can be estimated. The user may receive feedback on his past physical activity level in minutes or burned calories.

Several strategies have been explored to influence the user's behavior and promote higher physical activity levels. Most notably, the usage of virtual rewards [1,2], social support [3,9] and goal setting [8] have shown to be successful persuasive strategies to establish an increased amount of physical activity.

Recent medical literature reports that not only an inactive lifestyle may lead to adverse health effects, but also sedentary behavior itself is harmful. Prolonged sitting time is also dangerous for people who meet the WHO guidelines of 30 minutes of physical activity per day [4,12]. The reduction of sedentary behavior is hence identified as a target behavior that contributes to a healthy lifestyle. Support to create awareness of one's sedentary behavior may be beneficial. However, as Owen et al. state in [12], "given the recent recognition of this phenomenon of too much sitting, there are not yet any recommended clinical guidelines. Commonsense might suggest that it may be prudent to try to minimize prolonged sitting with 5 minute breaks every hour".

In this paper, we describe SitCoach, a mobile application that assists the user to create sedentary awareness and to have regular sitting breaks. Such an application can be combined with additional physical activity promotion features. To the best of our knowledge, SitCoach is the first prototype mobile application aimed to reduce sitting time. Using SitCoach, the goal is to collect insights into possibilities to influence people's sitting behavior using a mobile device.

SitCoach targets office workers, a group which is often also assisted by break reminder applications on their PCs. Such applications are developed to prevent their users from repetitive strain injuries. Although such applications show to be successful in reducing complaints [7], they may not always be pleasant to use [10]. Morris et al. [10] introduced SuperBreak, which stimulates break compliance for computer usage. Instead of the usual breaks offered by software packages such as XWrits and WorkRave, SuperBreak offers the possibility to make the break time more productive. By offering the user the possibility to interact with the PC through gestures during the break, break compliance is promoted and the productivity during the break time is increased. Hence, although SuperBreak may increase break compliance for computer work, it does not target a reduction in sitting time. Moreover, neither of the computer packages support break compliance during other sedentary time, e.g. during meetings or while reading.

After describing the SitCoach application in the next chapter, we present a first pilot user experiment to assess the usability of the application. Through a locus of control questionnaire and by means of a semi-structured interview, we gather additional insights on opportunities and techniques to promote sitting break compliance.

INTRODUCING SITCOACH

SitCoach is an iPhone application that measures physical activity by means of the built-in accelerometer. The application records active time and sitting time at a granularity of one minute.

To fight sitting time and inspire people to take a break once in a while, the SitCoach reminds users after a configurable number of in-active minutes via visual, acoustic and tactile messages. Users set their goals in terms of maximum number of consecutive sitting minutes and number of active minutes per day.

Identifying Sitting Time

Using the built-in accelerometer in the smart phone, the user's activity is classified in an active and inactive state. Every second a measurement of the phone's x, y and z positioning is taken by the accelerometer. These three values are compared with the previous measurement. When the difference for x,y or z exceeds 0.3 the accelerometer recognizes a movement. The 0.3 was determined empirically: it is low enough to pick up the walking movement of the user without getting a false reading from other possible movements like a small turn with the chair while sitting.

To distinguish walking from other smaller movements like a small turn or just standing up from a chair the movement will be monitored over a certain interval of time. An empirically determined value of 5 seconds proved to be sufficient.

Creating Sedentary Awareness

To motivate users to become more active, the application stores the number of active minutes per day for each of the users. This provides a social nudge for users to see how others are doing and to comply with the social norm.

When it is time to take a break, SitCoach emits a tactile (vibration) and an acoustic warning. Users can override the acoustic warning. A visual indicator at the main screen shows when a user is moving, giving the user immediate feedback about their current behavior. Figure 1 provides a screenshot of the main screen of SitCoach. The green circle indicates that the application has detect that the user is currently moving and hence the number of active minutes is increasing while in this state. In the state displayed in the figure, the user is nine inactive minutes away from a break reminder. However, if the user is active for a period equal to the actual time of the sitting break, the break timer will be reset.

Figure 1. SitCoach main screen.

A FIRST USER EVALUATION

To assess the usability and user acceptance of the application, SitCoach has been evaluated with users. This evaluation also provides insights into the participants' current sitting behavior and their awareness of the harmfulness of sedentary behavior. The goal of the study is to identify future directions for persuasive applications targeting sedentary awareness.

In the study, the participants are provided with an iPhone with the SitCoach application and are invited to use the application throughout a day at the office. At the end of the day, a semi-structured interview is conducted, to discuss experiences. Moreover, the participants are questioned about current sitting break habits and the awareness of the importance of such breaks is assessed. Apart from the interview, two questionnaires were handed to the participants: one focusing on the utilitarian and hedonic qualities of the application [5,6] and a second one focusing on the locus of control that people perceive with respect to possibilities to reduce their sitting time [13].

Participants

Eight participants (four females) were invited to participate in the experiment, during one working day. All participants were knowledge workers with high computer dependability.

Procedure and Design

The participants were scheduled on a day they described as a typical office day. Per participant, a day was selected without having appointments outside the office during working hours.

In the morning after arriving at the office, the participants

received a fully charged iPhone 3G. SitCoach was the only application installed, apart from the standard software. The participants were instructed not to use the phone for other purposes. No SIM card was installed, limiting the functionalities of the phone.

During the intake meeting, the participants were explained the functionality of the applications and guided through the features and settings. The standard break timer was set to 60 minutes, prompting for a 5 minute break. The standard activity goal was set to 50 minutes. The participants were free to change the settings throughout the day.

Around 4 o'clock in the afternoon, the participants were interviewed based on a list of pre-defined questions on their sitting behavior, sedentary awareness and the SitCoach application. Moreover, the two questionnaires were handed.

The Attrakdiff2 questionnaire was presented to assess both the pragmatic and hedonic qualities of SitCoach [5,6]. His scores on both qualities are important for the prolonged usage of a product. Specifically, the questionnaire measures perceived pragmatic quality, hedonic quality identification (i.e. does the product contribute to the user's identity in a social context?), hedonic quality stimulation (i.e., does the product help to develop skills or knowledge) and attractiveness (is the product good, bad or ugly?). Each of those four categories contains seven word-pairs on a seven point semantic-differential scale (e.g. discouraging vs. motivating, complicated vs. simple).

To assess the perceived locus of control to influence one's sitting behavior, a locus of control questionnaire was assessed [13]. The commonly used questionnaire, developed by Wallton et al., is adapted for sitting behavior. The questionnaire measures whether the control over the sitting behavior is determined internally (i.e. self-control; example statement*: If I take care of myself, I can avoid long sitting periods*), by others (e.g. *Whenever I feel I sit too much and too long, I should consult a trained professional*.) or by chance (e.g. *No matter what I do, I 'm likely to have long sitting periods*).

Results

All participants indicated that they were not aware of the harmfulness of sedentary behavior itself. When taking a break and getting up from their desk, the participants did so because they were aware of the adverse effects of prolonged computer usage and the healthfulness of physical activity. Half of the participants reported to be unhappy with the amount of sitting time during a day in the office. Suitable moments to take a sitting break are in between tasks and when feeling less concentrated. The time spent during such breaks is not seen as productive.

The lack of control is seen as the largest source of annoyance with PC break applications. Only one of the participants is using an RSI prevention program on the PC, which is installed by default. The others have disabled it. For a mobile application to create sedentary awareness, the perceived control over the sitting breaks should remain with the user.

The interviews showed that the phone vibration to signal break alerts was appreciated as it is discrete and easy to ignore when needed, for example during meetings. On the other hand, the buzzing signal was experienced to be distracting: "When I am working, I don't want to be disturbed".

The Locus of Control questionnaire revealed that six out of eight participants scored low on the internality dimension (scores < 18 on a range from 6 to 36), while the other scored moderate ($18 \leq$ score ≤ 24). This implies that the office workers participating in the study believe that they have little control over their sitting behavior. With overall higher scores on the powerful others dimension, it is believed that others (colleagues, managers) strongly determine the participants' sitting behavior.

The Attrakdiff2 questionnaire results show favorable scores on the pragmatic dimension, implying that the participants are generally positive about the interaction with the SitCoach application. No remarks were made about any inaccuracies of the application. This suggests that the current implementation is well usable to distinguish sitting time from active time. Lower scores were reported on the hedonic dimensions, most notably on attractiveness.

Table 1. Users' responses to the locus of control questionnaire.

Participant	Internality	Powerful others externality	Chance externality
Person 1	Moderate	Moderate	Low
Person 2	Moderate	High	Moderate
Person 3	Low	High	Moderate
Person 4	Low	High	Moderate
Person 5	Low	Moderate	Moderate
Person 6	Low	Moderate	Low
Person 7	Low	High	Low
Person 8	Low	High	High

Some of the participants reported battery problems with the smart phone. Although the participants received a fully charged phone, the battery time was not enough for the application to run for the whole working day. Hence, in future work, solutions should be researched that take the energy consumption of the phone into account when running such accelerometer-based applications.

The functionality to share the activity minutes on FaceBook or other social media was not well received. Similar to the

findings of Munson et al. [11], participants did not feel the need to bother their social network with such details.

Table 2. Users' responses to the AttrakDif2 questionnaire.

Ppn	Pragmatic Quality	Hedonic Quality Identification	Hedonic Quality Stimulation	Attractiveness
1	High	Moderate	High	Moderate
2	High	Low	Low	Low
3	Moderate	Moderate	Moderate	Low
4	Low	Moderate	Moderate	Low
5	High	High	Moderate	Moderate
6	High	High	High	Low
7	High	Moderate	High	Low
8	High	Moderate	High	Moderate

CONCLUSION AND FUTURE WORK

In this paper, we presented an application to assist people to control their sitting behavior. The mobile application combines feedback on physical activity with insights on the user's sitting periods. SitCoach was developed to gain insights into people's awareness of their sedentary behavior and the user acceptance of a break reminder application.

With SitCoach, we have created an application that detects sitting time with fair accuracy. However, the users involved in the trial showed not to be in the right stage of change to be responsive to the strategies applied in SitCoach. Persuasive strategies to stimulate the user to take sitting breaks are likely to be more successful after having established awareness of the adverse health effects of sitting behavior. This can be done by first providing insights in one' sitting behavior and subsequently suggesting opportunities to reduce sitting time. For users who are aware of the problem and the adverse effects of their behavior, the triggers applied in SitCoach may be revisited.

ACKNOWLEDGMENTS

This work was funded by the European Commission, within the framework of the ARTEMIS JU SP8 SMARCOS project – 100249 - (http://smarcos-project.eu).

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