ESTHER 1.3: integrating in-situ prompts to trigger self-reflection of physical activity in knowledge workers

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ABSTRACT
There are little initiatives supporting knowledge workers in implementing physical activity as part of their work routines. Due to the sedentary nature of their work, knowledge workers have little opportunities to engage in physical activities during the working hours. In addition, physical activity is not a priority in their busy agenda, which results in knowledge workers been unaware of their physical behavior at work. Behavioral models are considering both self-reflection and self-awareness processes as key elements for an individual to take action over desirable behaviors. Considering self-reflection as the mean to achieve self-awareness, the design of persuasive technologies for physical activity is challenged to go beyond supporting data collection and visualization of physical behavior to actively support the process of self-reflection. This paper introduces ESTHER 1.3 as an approach to facilitate active mini cycles of self-reflection on physical activity by means of in-situ self-reporting mechanisms. ESTHER 1.3 will be tested in the field to explore how the implementation of these mechanisms assists the planning of physical activity targets during work time and how the performance of these targets differ compared to when the application only provides physical activity information. With the ultimate goal to integrate physical activity into a person's daily work routines, the design of ESTHER 1.3 based on Personal Informatics (PI) by encouraging deeper reflection on collected data to perform better-informed actions.

Categories and Subject Descriptors
D.3.3 [**Information systems**]: Information interfaces and presentation (e.g., HCI) – *Miscellaneous.*

General Terms
Design, experimentation.

Keywords
Physical activity, personal informatics, knowledge workers, self-reflection, self-awareness, prompting mechanisms.

1. INTRODUCTION
Wellbeing at work has become particularly important in the context of knowledge workers, as the stress and sedentary work associated to office work leads to unhealthy work practices characterized by insufficient physical activity, which raises the risk of numerous diseases [1,2]. More than a quarter of all employees in The Netherlands have sedentary work and sit on average 4 hours while being at work and travelling to and from work [2]. Knowledge workers' agenda is driven by task completion, scheduling and planning what activities have to be done on daily basis. Unaware, knowledge workers could spend an entire day switching between tasks overlooking health behaviors at work such as taking breaks that involve physical activity.

In an effort to promote physical activity at work, most initiatives refer to company's policies and campaigns to reduce sedentary behavior by promoting regular work breaks as opportunities to perform some physical activity [3,4]. However, these initiatives do not directly support the worker to implement and accomplish the minimal required in physical activity at work. On average a worker should accumulate at least 30 min of moderate-intensity physical activity, either during work, during the lunch break, or on the way to or from home [5]. In practice, knowledge workers require supportive tools beyond policies and infrastructures to help them to self-reflect and become aware of their physical activity levels to be able to integrate more physical activities in their schedules without affecting their work routines.

Personal Informatics (PI) is an emerging area in the field of Human-Computer Interaction that facilitates people to collect personal relevant information for the main purpose to support self-reflection and gaining self-knowledge [6,7]. PI implements five consecutive steps to support behavioral change: preparation, collection, integration, reflection and action [7]. Despite the importance of self-reflection in PI systems, most of the developments to date have been focused on supporting collection and representation of objective data by integrating automated sensors, data processing and attractive visualizations.

The main challenge is to support an automated integration stage that facilitates the user in processing large set of data, leaving the user alone in the stages of reflection and action. Their passive role in the integration process results in visualizations that are far from personal, which hinders an effective reflection on it. Short but active involvement of the user in the integration stage may result in visualizations more personalized; the design will then actively support the user in their reflection process. In line with [8,9] the challenge in PI regards on the collection of data and the design of meaningful information towards in-depth self-reflection.

In this paper, we describe ESTHER 1.3, a personal informatics mobile application with the main purpose to facilitate active mini cycles of self-reflection of physical activity during working time. These mini-cycles comprise in-situ prompting mechanisms of self-reporting regarding current mood state and activities. The work described in this paper aims to contribute to the design of Personal Informatics technologies by going beyond collection and integration, becoming an active trigger to stimulate the reflection process integrated with the collection of objective/automated data. The following sections discuss the related work, describe this application, present the settings of a pilot user experiment and provide the expected results of the proposed experiment.

2. KNOWLEDGE WORKERS' PHYSICAL ACTIVITY

Adult knowledge workers are unaware about how (in)active they are at work [10] easily adopting sedentary behaviors due to the nature of their work with prolonged sitting over 4 hours [11]. Their work is characterized by easily switch tasks making their daily work life very fragmented [12] and with the urgency to accomplish tasks getting totally engrossed during a three-hour time frame [13]. When confronted to such intense work habits, knowledge workers put their health at risk. Although there is a substantial body of literature confirming the need of at least 30 minutes of physical activity at work and hourly breaks of 5 minutes, the level of sedentary behavior is increasing [14]. The lack of self-awareness makes difficult for knowledge workers to implement health-related solutions into their daily schedule, as well as limiting the effectiveness of physical activity interventions [15]. Implementing breaks that involve walking for at least 5 minutes requires knowledge workers to reflect on their work routines without affecting their current work responsibilities.

3. RELATED WORK

In the context of knowledge workers, Office Exercise and Exercise Booster are Android applications for people with sedentary jobs. The first one hints its users to execute specific instructions as not to keep the same posture for too long, for example hold the phone above your face and keep it there for a while. The latter is an application that helps keeping a record of exercise sessions (manual entry). This application allows planning and scheduling displaying weekly activity in a progress bar. WalkMinder [16] encourage physical activity and self-awareness by a glanceable display and mobile phone vibrations to interrupt extended periods of inactivity. MoveLamp [17] is an ambient light display that serves as reminder to move, as a feedback on recent activity during work occupation.

Most of these systems are limited in providing detail information to help users make informed health decisions [16], as they primarily support collection and visualization of objective data. As mentioned by [18], current personal information technology is being designed to optimize productivity rather than self-understanding. Physical activity behavioral change is also related to identify opportunities thus focusing only on the level of physical activity may not be sufficient [5]. Moreover, these systems have a more persuasive approach where the focus is on providing engaging instructions rather than increasing reflection. As pointed by [8], there are a limited number of studies that focus on the process of reflection in designing personal informatics systems. Furthermore, in our understanding, there are no systems that support knowledge workers in capturing deep reflections in physical activity helping them to find opportunities to improve physical behavior change.

4. ESTHER 1.3

ESTHER 1.3 is a mobile application that aims to support self-reflection in knowledge workers' physical activity during working time. It features daily activity planning, physical activity monitoring and in-situ prompting mechanisms of self-reporting. Based on a minimal recommendation of 2000 steps during working time [17], ESTHER 1.3 advises the knowledge worker to perform at least 1 activity of 5 minutes walking every three hours, with a total of 4 activities in a day. According to personal work routines, the user is able to set and schedule these activities by assigning targets on a ring circle, which represents a workday of 12 hours (6am to 6pm). ESTHER 1.3 monitors physical activity by using a pedometer application calculating and collecting number of steps from the in-built accelerometer. A second inner ring circle divided in segments of 5 minutes represents the physical activity intensity over the day with 4 different colors. Unlike applications that only collect performance data and encourage self-reflection by persuasion and complex visualizations, ESTHER 1.3 builds on these systems by empowering the user to have deeper reflection moments. For this, ESTHER implements mini cycles of self-reflection by means of in-situ prompting mechanisms of self-reporting. The user is able to self-report the current mood and work activity. The scheduled targets of walking, the intensity of the walking behavior over the day and the self-reporting information is presented in a daily overview screen providing the user with detailed and meaningful information to follow his/her real physical performance overtime in relation with the planned targets.

4.1 Physical activity monitoring

ESTHER 1.3 uses an open source Android pedometer application to monitor physical activity. The use of pedometers is an unobtrusive and effective way to measure activity [19] and it is suitable to assess the level of physical activity in knowledge workers, as walking is considered a moderate activity if done frequently [17]. The application counts steps while the worker is carrying the phone in the pocket aiming to sense small but significant activities during working time, such as going for a coffee or having lunch. The number of steps for healthy adults ranges from a sedentary lifestyle (<5000 steps/day) to a highly active lifestyle (>12500 steps/day) [20]. For a workplace scenario, ESTHER 1.3 supports the typical 8 hours work day, in which the knowledge worker should make at least 2000 steps as a minimum physical activity goal [23]. This represents in total 20 minutes of physical activity as researchers have determined that a rate of at least 100 steps per minute achieves moderate intensity activity [21]. In order to provide detailed representation of physical activity over the day, a ring circle is broke down into small segments to 5 minutes to show in real-time the physical performance. Four different performance are represented by 4 colors: gray=non-existing activity/0 steps/0 min.; red=low/100 steps/1 min.; yellow=medium/300 steps/3 min.; and green=high/500 steps/5 min. This data is calculated from the in-built accelerometer and assessed by the pedometer application.

4.2 Scheduling targets of physical activity

In order to accomplish the minimum of 2000 steps as a daily physical activity goal, ESTHER 1.3 advises the user to schedule and assign on an outer ring circle ≥ 4 targets of 5 minutes walking over the day (Fig. 1). Each target of 5 minutes represents 500 steps as the minimum threshold. This ring circle represents 12 hours starting from 6:00am to 6:00 pm. Furthermore, based on the findings of [12] stating that knowledge workers have the tendency of working in time frames of 3 hours, this ring circle is divided in

4 segments. This division in quarters has the objective to facilitate the assignment of targets of physical activity based on personal work routines over the day, as well as encourage the user to have a balanced the number of targets between morning and afternoon sessions. The knowledge worker assigns these targets at the beginning of the day, dragging them over the ring circle (Fig. 1). By doing this, the user has to reflect about his/her current work routines, thinking ahead how and when these activities can be achieved. Targeted activities are displayed by default in a green color enabling the comparison of the planned activity on the outer ring circle vs. the real activity performance on the inner circle at a particular time. This, will help the user to spot, for instance if the activity at lunchtime was whether achieved or not (Fig. 2).

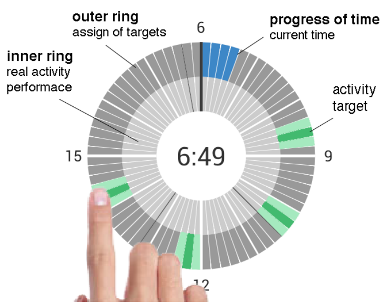

Figure 1. User assigning targets at starting the working day

4.3 Integrating mini self-reflection cycles

ESTHER 1.3 aims to actively support mini self-reflection cycles by implementing in-situ prompting of self-reflection. As mentioned by [8], reflection is a process in which one thinks and explores an issue of concern to make it meaningful for oneself, leading to the development of a new conceptual perspective. These mini-cycles aim to support this process by providing meaningful information elements for the user to self-explore the issue of concern, in this case to be more active during working time, and therefore, facilitate new mental perspectives, in this case the future planning of short but frequent small physical activity moments during working time. This meaningful information comes from in-situ self-reporting mechanisms. It has been reported that this mechanism increases awareness in physical activity [19], as well as it provides motivation to use this technology when users seek to understand relationships between different sources of data [22].

With a fixed amount of 1 prompt every quarter, the application triggers a prompt whether a scheduled target meets the recommended high performance (green); if there are no achievements it prompts on the last target scheduled within the quarter or if there are no scheduled targets on the quarter. When a prompt is triggered the knowledge worker receives a notification on the phone in a form of vibration and sound. On the screen a exclamation word is displayed representing three different status of physical performance when comparing the level of activity monitored with the assigned target: WOW= the scheduled target met the recommended activity/both target and real activity are green; OK= the scheduled target is average/the target activity is green while the real performance is yellow; and OOPS= the scheduled activity is low or there was no activity/the target is green while the real performance is red or gray. These exclamations aim to encourage the user to self-report. With a prompt, the user provides his/her current emotional state by selecting 1 mood between 5 possible options: happy, confused, annoyed, great and sad. Next, the user provides contextual information by selecting the activity that he/she was doing at the moment of the scheduled target. The user can select a maximum of 2 activities between 5 pre-defined options: meeting, working, eating, phone, and chatting, with an option for other activities.

Additionally, the user can add an extra mood at the current moment. These moods will be also displayed on the screen at the time they were reported. Besides, the user can add open comments at any time of the day. This information will be accessed and presented on an in-built notepad. In order to provide more valuable information elements for the user to evaluate and self-reflect towards better-informed actions for next day, a screenshot of the results of the previous day of physical activity is available by swapping the screen from left to right.

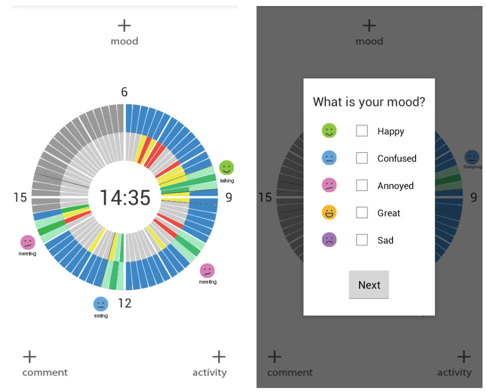

Figure 2. Overview of activity performance, targets, and self-reporting inputs (moods and activities). Moods window.

5. STUDY

The goal of this study is to investigate how the implementation of self-reporting mechanisms assists the planning of target activities and how the performance of these targets differ compared to when the application only provides physical activity information. Three versions of ESTHER 1.3 are tested in the field with knowledge workers. The first one acts in the background collecting only physical activity base-line information; the second one supports real-time physical activity monitoring and planning daily targets; and the third one features the mini self-reflection cycles.

5.1 Procedure

For this study 14 knowledge workers (6 female) are invited to participate, all of them volunteers from a local company in The Netherlands. Their average age is 32.2. This study has three stages over 4 weeks, comprising 5 working days baseline phase followed by 10 working days with the control condition and finally 10 working days with the experimental condition. All participants contribute to the baseline; afterwards half of them are assigned to start with control and half with experimental conditions for the first 10 days and then alternate to cancel out sequence effects.

In the baseline phase participants are asked to fill in a background questionnaire to establish self-perceived physical activity level during working time. The questionnaire is based on the Flemish physical activity computerized questionnaire (FPACQ) [19] aimed at office workers. A version of ESTHER 1.3 without visualization and prompts is installed in participants' smartphones to determine their regular physical activity patterns of a working week. The application collects and stores data locally. Participants are asked to carry their phones on their pocket following their normal daily office routines. Participants initiate the application by specifying username. In the control condition a feedback-only app is installed on participants' phones, providing the wheel visualization regarding target and current physical activity information.

Participants can set targets and see the visualizations but they do not get prompts. In the experimental condition the prompt-based app is installed on their phones including the self-reporting mechanism. This condition aims to establish how self-reporting may increase self-awareness to do more informed activity planning relative to the control condition. The study ends with a semi-structured interview to discuss participants' experiences and possible changes in planning strategies, along with a questionnaire to establish their new self-perception level of physical activity. With the results of measuring the frequency of self-reporting, the changes in planning targets and its relation to real-time physical performance, analyzing qualitatively the self-report inputs and their relation with targets, as well as the interviews and the self-rated physical performance questionnaires we can describe the influences over self-awareness in physical activity.

6. DISCUSSION

Although data collection and reflection are considered an integrated process in personal informatics [6], most of the systems focus on supporting the technicalities of collecting and track physical activity. While facilitating the visualization of large data sets, the passive role of users in these stages creates a distance between the user and the data, which hinders engagement and proper understanding of their current behaviors. Designing for active participation in these stage may help users to feel the data closer to them [10]. Going beyond the support of visualization of performance data, ESTHER 1.3 aims to actively support self-reflection with the integration of sensed and in-situ self-reporting information, empowering the user to gain a better understanding. It is proposed that these mechanisms subtly and even unconsciously influences knowledge workers' self-reflection during work time. This provides the user with more meaningful information elements to follow a more deeper and critical reflection. Self-awareness is not "one-time" process. It requires reflection, thinking and exploration of one's behaviors in meaningful moments over time. Self-reporting may improve awareness of (inadequate) physical activity levels as it has the potential to drive self-learning and self-reflection, and therefore, preparing the user to perform better-informed actions.

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