Opportunities for Productivity and Wellbeing: Human Sensing in the Workplace

要　旨

【キーワード】
ヒューマンセンシング、生産性、良好な状態、
ウエルビーイング、個人情報

モバイル技術の発展と日常生活における継続的なつながりは、仕事の進め方に大きく影響を与えている。センシング技術の活用は個人による使用事例が多くを占めているが、ワークプレイスはセンシング技術を活用するのに重要かつ適切な環境である。つまり、従業員が自分の追跡可能な端末を使ってセンシング技術を連携させることが可能である。本稿では、ワークプレイスにおける身体的、精神的、および社会的に良好な状態と生産性を向上させる技術について、2つの最新の調査結果と、行動を変える姿勢を維持するための仕組みを報告する。次に、新しい作業の領域について簡単に議論する。

Abstract

【Keywords】
human sensing, productivity, wellbeing, personal informatics

The growing influence of mobile computing and constant connectivity in people's daily lives, has dramatically affected how work is done. While the majority of focus of sensing technology use has been on personal use-cases, the workplace is an important and well-suited setting for combining managed sensing technology in the workplace with personal tracking devices introduced by individual workers.

In this paper, we report two recent explorations of understanding the role of technology in promoting wellbeing and productivity in the workplace, and mechanisms to help sustain participation in behavior change. We then briefly discuss new areas of work.

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1. Introduction

The growing influence of mobile computing and constant connectivity in people's daily lives, has dramatically affected how work is done. The last decades have brought sensing technologies to personal devices. As the cost of computing decreases and the availability of networking continues to grow, a shift has taken place with wearable sensors, environmental sensors, and connected everyday devices moving from the research realm to reaching consumers. Wrist-worn sensors (often in the form of smart-watches) and belt-clip sensors, connected to mobile devices that provide strong computation and continuous connectivity, offer continuous biometric and motion sensing. GPS and wireless beacons spread through a space (as in [2, 3]) offer outdoor and indoor localization in managed and unmanaged environments. For wearable sensing, the focus has so far been predominantly on personal uses. These include tracking of physical activity and sleep (using accelerometers, gyroscopes and heart-rate monitors), and more recently, wearable sensors that promise to detect (and warn) oncoming epileptic seizures [8] or stress [16]. However, while the focus has been predominantly on personal uses, the use of these technologies for workers and the workplace has been under explored. Yet, as an IT-managed environment, the workplace offers opportunities for merging personal worn and carried sensors, with sensing infrastructure. At Fuji Xerox and FXPAL we are investigating the potential of these technologies for changing the workstyle of employees and organizations.

In this paper, we describe two complementary areas of exploration that involve understanding the role of technology in promoting wellbeing and productivity in the workplace, and mechanisms to help sustain participation in behavior change. These are abridged accounts of longer reports. We conclude with descriptions of our follow up research activities.

2. Work-Breaks, Productivity and Opportunities for Personal Informatics

In this section, we report an investigation of the link between work-breaks, wellbeing and productivity. We then present an exploration of the potential of break logging for personal informatics, through the design and study of visualizations using field-study participants' data, self-observations and open questions. A detailed account of this work can be found in [9].

2.1. Background

(1) Break-taking Objectives and Practices

Prior work has shown that frequent breaks reduce accidents and physical discomfort in industrial environments [18,19]. Researchers have also studied the role of breaks in office environments for avoiding repetitive strain injury, muscle fatigue, and excessive sedentary behavior [4,10,17,18]. There is, however, disagreement on whether short, frequent breaks are preferable to longer, infrequent breaks [6,11,17].

On the flip side, workers often forego taking breaks to maintain productivity or because of pressures in the work environment. Although Rogers et al. found that nurses made no additional patient-care mistakes during shifts when they were unable to take a break, they note that missing breaks promotes bad eating habits (e.g. taking advantage of readily-available unhealthy snacks) and contributes to burnout [14].

Approaching the question of break-taking objectives from a personal rather than an organizational angle raises the question: What benefit do knowledge workers desire when they take a work break?

Previous studies, such as Czerwinski *et al.*'s diary study [5] and Mark *et al.*'s in situ study [13] have documented an array of workplace activities of knowledge workers. These studies also captured some of knowledge workers' break activities, such as downtime or personal tasks and social network use. Mark et al. report participant's emotional valence and arousal showed no significant change after a mid-day break, but note an increase in web email and Facebook after that mid-day break [13]. In our work, we address specifically the impact of varied break activities on desired benefits and productivity.

Insights gained through this question could benefit, for example, the design of break-recommendation systems that promote beneficial activities and dissuade others.

2.2. Understanding Breaks from Work

We started with a survey of 147 US-based knowledge workers solicited through posts to social media and university mailing lists (a convenience sample) and through Amazon Mechanical Turk (AMT). The survey focused on gaining an understanding of criteria used by knowledge workers to define breaks (and whether definitions of breaks differ across workers), and an understanding of the benefits workers desire out of their breaks.

Table 1 presents a summary of demographics and the top respondent occupations. While our sample includes a wide

Table 1. Demographics of survey respondents

	AMT (N=100)	Convenience (N=47)
Age	Avg 32.8, min 21, max 64	Avg 31.8, min 20, max 81
Gender	45 Female, 55 Male	32 Female, 14 Male, 1 did not disclose
Most Common Occup.	20 computer & math 15 office & admin support 14 business & financial 11 sales	20 student 10 computer & math 4 research 3 design

variety of U.S.-based knowledge workers, it is certainly skewed towards technology-related professions. We quote respondents with S##, where S1-S100 and S101-S147 were recruited from AMT and convenience samples, respectively.

2.3. Survey Results

(1) What is, and is not, a work break

To understand which activities knowledge workers consider breaks and why, we compiled a list of 18 activities that had been considered or referred to as a work break in the literature [7, 12, 13, 15, 18]. The list contains both physical and digital activities (see Figure 1). In the survey, respondents were asked to indicate, for each activity in the list, whether they considered it to be a break from work, regardless of whether they themselves took it. For each activity a respondent marked as not a break, they were asked to briefly describe why not.

Of a total 2646 entries (147 respondents x 18 activities), 1878 were marked as “a break” and 617 (4.2 entries out of 18 activities per respondent, on average) as “not a break”. In other words, a large proportion of activities described in prior work were not considered breaks by the respondents.

(2) Work-related activities are not breaks

One clear classification of activities that emerged from the responses was that activities related to work were rarely considered breaks. 124/147 respondents (84%) did not consider managing work email or instant messages to be a break from their work. Work email was thought of as “part of my job” or “work related” (S10, S146, mentioned by 118 others). 7 and 5 respondents felt reading news or websurfing were related to their work, respectively. This is often required for of certain professions, such as S77, who said “my job requires me to keep up with the news, especially Real Estate news.”

This result highlights two important points: First, many of these work-related activities have been considered breaks in the literature, and may thus require established implications around task management to be rethought. Second, it also illustrates that an activity (e.g. reading real estate news) may be a work related task to one worker (e.g. a real estate agent) but not to another (e.g. an office assistant currently looking for a home to purchase). This has significant implications for any automatic classification of activities as being breaks.

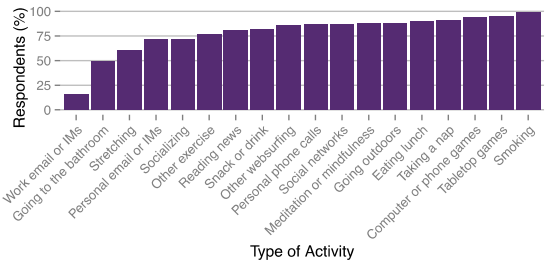

Figure 1. % agreeing activity X is a break

(3) Desired benefits were shared, but subjective

When asked to explain what makes a break good and/or successful, 112 respondents (76%) referred to a desired mental state upon returning to work. Examples include breaks that “cleared my mind”, where they returned “refreshed”, “refocused”, “relaxed”, or “recharged”, or that the break “lowered my stress.” An overall theme was that workers return from a successful break feeling ready to work.

Respondents described different ways of returning from a break ready to work. Fifteen respondents stated the need for breaks to provide a new perspective on their current work task: “sometimes it helps [me] to get some distance from a problem and then go back to it.” (S147). A successful break for S29 “tak[es] my mind off work for a bit”, a sentiment shared by 28 others. While there is consistency in the descriptions of the qualities of a “good” break, the evaluation of each break activity is clearly subjective.

(4) Undesirable outcomes of breaks

For many survey respondents, undesirable outcomes of breaks were simply the inverse of desirable outcomes. They “don’t feel relaxed” after a bad break (S42 and 34 others) or “think about work the entire time” (S58 and 31 others). Twenty-two respondents described a bad break as one interrupted by work, such as being “called about work” (S76) or “having to talk to others about work” during a break (S83 and 7 others).

Finally, the length of a break may lead to a break being seen as unsuccessful. Respondents described a bad break as being too short or too long, such as, “if I do not have time to enjoy my break,” or, “if I take too long, or if someone starts what looks to be a long conversation.”. In both cases, respondents referred to the length of a break in relative terms (too long/short). We explore the relationship between break type, break length and outcome.

2.4. A Field Study of Breaks from Work

Towards our goal to understand potential technology opportunities to assist workers in managing and improving their productivity and wellbeing, our investigation now turns to exploration of the relationship between work-breaks and the benefits they may provide to a knowledge worker’s physical and mental states and productivity.

(1) Methods

We created a website for both desktop and mobile for logging detailed information about breaks throughout the day. A complete entry consisted of three parts (labeled 1, 2, and 3 in Figure 2) allowing us to collect rich data and enable identification of temporal (and causal) relationships:

(Ⅰ) Whenever they are about to take a break, participants are asked to start a new log entry and to describe what they were working on, why they decided to take a break, and to

Figure 2. A conceptual flow of work and work-breaks

evaluate their level of productivity.

(Ⅱ) Upon returning from a break, participants indicate that they had returned, describe what they did on their break, whether it was longer or shorter than intended, and rate their end-of-break state. Participants then return to their normal work.

(Ⅲ) Finally, 10 minutes after resuming work, participants receive an alert asking for the final part of the entry, including their current activities and productivity ratings.

This sequence helps expose the relationship between productivity before the break and the break itself and their combined effect on productivity after the break.

(2) Participants and Analysis

We recruited 28 participants for a two-week study through posts to social media on personal timelines and high school and university alumni pages. No two participants were from the same organization. Participants were compensated $5 for each of the first 5 days in which they logged breaks, and $10 per day thereafter, for a maximum compensation of $75.

Participants logged 885 breaks in total. In our analysis, we discarded 64 breaks because participants did not report coming back from them, and 21 breaks that were logged more than 30 minutes after the break was over. Of the 800 breaks we report on, 786 breaks were logged using a desktop browser and 14 (2%) were logged via a mobile device.

Across all participants, the three productivity-level ratings (work quality, focus, productivity) were highly correlated. We thus combine the three into a single *Productivity* rating. We found a similar high correlation in the end-of-break reports between the relaxed and refreshed break-quality ratings (r=0.76, p<0.001) and combined these ratings.

2.5. Field Study Results

We now report the results of our field study, summarized in graphical form in Figure 3.

(1) Productivity and the Decision to Take a Break

An initial question we ask is “How does work productivity affect a knowledge worker’s decision to take a break?” To answer this, we examined the proportion of breaks taken given the value of reported productivity before the break. Our analysis found no significant effect ($F_{1,550}=0.07$, $p=0.796$), suggesting that participants took breaks with similar frequency whether they felt more or less productive.

We did find, however, a significant effect of pre-break productivity on the *type* of breaks participants took (refer, again, to Figure 1 for the full range of break types). We found participants tended to take Digital breaks (such as checking personal email or visiting social networks) more often when they feel less productive ($\beta=-0.218$, $Z=-2.41$, $p=0.016$), but when feeling more productive, Necessary breaks (such as going to the bathroom or getting a snack) were the ones more likely ($\beta=0.200$, $Z=2.19$, $p=0.028$). Other break types were not taken significantly more or less often based on productivity.

Looking at specific categories of Digital breaks, we found participants took Social Network and Websurfing breaks more often when they felt less productive ($\beta=-0.195$, $Z=-2.06$, $p=0.039$; $\beta=-0.218$, $Z=-2.22$, $p=0.027$) and marginal significance for Digital Games breaks ($p=0.055$).

(2) Refreshed, Relaxed, and Ready to Work!

We also examined what affects a person feeling relaxed and refreshed at the end of a break, and whether those affect readiness to resume work. Looking at break types, Physical Rest breaks were correlated with people feeling relaxed and refreshed ($F_{1,779}=8.96$, $p=0.003$). Confirming our finding from the survey, breaks that were shorter than intended were correlated with feeling significantly less relaxed and refreshed at the end of the break ($F_{1,784}=29.06$, $p<0.001$). While longer breaks were correlated with higher ratings of being relaxed and refreshed ($F_{1,785}=13.02$, $p=0.003$), breaks longer than intended were not ($p=0.633$). Taken together, these results

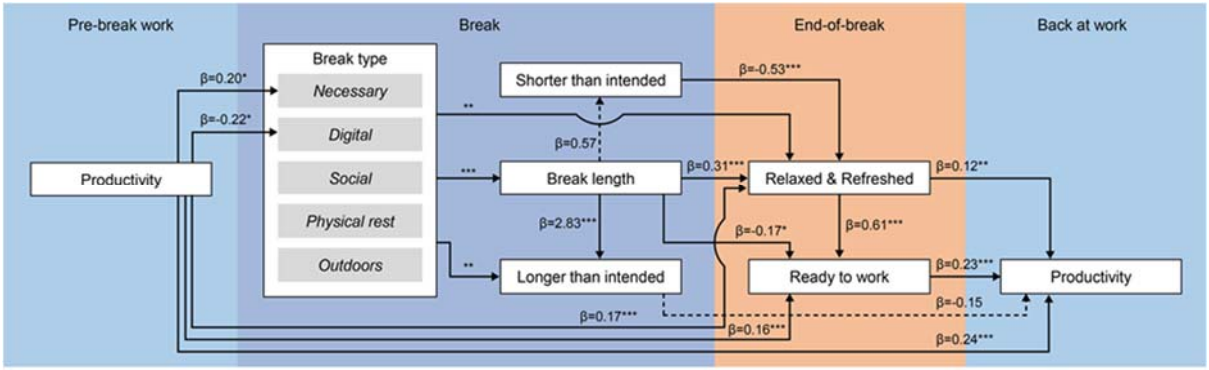

Figure 3. Regression analysis results across conceptual flow (- - - p<0.1; * p<0.05; ** p<0.01; *** p<0.001). Effects of hour-of-day and day-of-week not shown.

suggest that being refreshed and relaxed is more strongly affected by breaks that are too short, rather than breaks that are too long. Finally, participants reported feeling less ready to return to work as the day went on ($F_{1,785}=19.42$, $p<0.001$) and as the week went on ($F_{1,775}=6.16$, $p=0.013$).

(3) Work-breaks and Productivity

For the final piece of our model, we analyze the connection between the work-break factors examined and participants' productivity, reported 10 minutes after resuming work. Of the 800 breaks reported, 627 (78%) contained back-at-work responses and were used in this analysis. We conducted a linear mixed model analysis with the combined Productivity rating as the dependent measure.

Our analysis shows significant effects of feeling Relaxed and Refreshed and Ready to Work (at the end of the break) on productivity 10 minutes later ($F_{1,579.3}=2.77$, $p<.006$; $F_{1,634}=5.78$, $p<.001$). This finding suggests that a break that leaves a knowledge worker refreshed and relaxed, and thus ready to work will positively affect their work productivity.

2.6. Breaks and Personal Informatics

Based on the responses of our field study participants, we developed and iteratively refined visualizations for 13 topics for learning and reflection on breaks, in four categories:

- Overview of break habits
- What impacts break duration
- What impacts feeling refreshed after a break
- What impacts productivity

Visualizations were made with ggplot with field study data. We used three types of plots: histograms (Figure 4a), point ranges (Figure 4b), and scatter plots with trend lines. Each visualization contains a summarizing natural language caption. These captions were automatically generated by running statistical tests at $\alpha=0.3$ and interpreting the results.

To evaluate the 13 visualizations, we contacted 19 of our 28 field study participants who indicated willingness to be contacted and had logged breaks at least five days. 9 of the 19 participants responded and were scheduled for a phone interview.

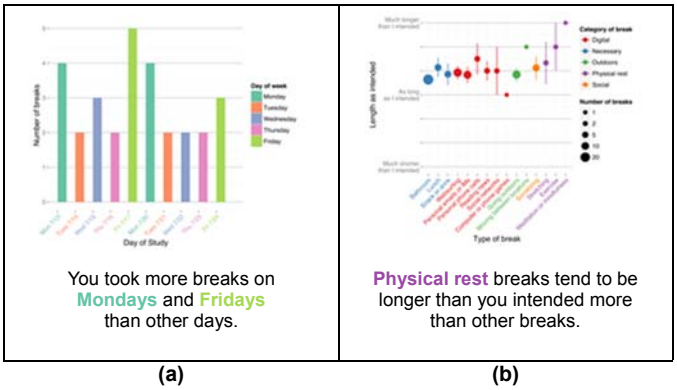

Figure 4. Example visualizations and natural-language captions presented to Study 3 participants

(1) Results

Visualizations helped participants identify break-taking trends. P13 learned when she took breaks, "I didn't know that my break habits drop in the afternoon." P10 learned that "most of my breaks were a little bit shorter than I intended, which I didn't know." P16 was surprised to learn "how little my breaks refreshed me… I would have thought that in most instances it would."

As participants looked through the visualizations, they identified ways to change their break-taking practices. P16 considered changing when he took breaks to spread them throughout the day: "I have very few breaks after two o'clock. So I probably might be better off trying to even out my breaks more over the day." P28 found that "it's pretty clear that the longer my break is, the more likely I am to not feel refreshed… I should keep my breaks a little shorter."

Participants mostly described changing the types of breaks that they took. P1 wondered, "I feel like if I want to feel more refreshed, maybe I need to get up and walk around and not get sucked into technology."

2.7. Implications for Break Recommender Systems

The relationship between productivity before and after a break suggests that exploring the link between work tasks and break habits in detail is still necessary. Due to the large number of unique task descriptions by our participants, our models did not include individual work tasks. However, break recommendation systems should not only consider whether a work task is interruptible, but also how work task influences what break activities might be more or less appropriate. While a short break remaining at a desk may preferred during a data entry task, people may seek a longer break away from their work environment in the midst of a creative task.

3. System-Driven Lapse Management

The use of technology for personal behavior change has grown tremendously in the last decade. People use a variety of devices and apps to support their pursuit of diverse goals, from increasing physical activity to changing dietary habits, saving money, or reducing stress/environmental impact. Yet, personal behavior change, with or without technology, is a difficult process that requires motivation, discipline, and perseverance. When a person fails to perform their desired behavior (or fails to avoid an undesired behavior), they are said to "lapse." Lapses, as years of research in behavior change have shown, can lead to other lapses and, ultimately, to quitting the behavior change

altogether (in the domain of addiction research, abandoning a behavior change effort and returning to old habits is referred to as “relapse”).

For a service provider or device manufacturer, sustained user engagement is critical. Thus, helping users manage their lapses reduces the risk of losing users. We investigate the use of “cheat-points” as a mechanism to allow users to manage their own lapses. In our system, the cheat points are granted, are personalized to a person’s goal, and help them manage (plan) for lapses before they happen. Using cheat-points could occasionally allow a user to recover from a lapse (if they perform a behavior they should not), or allow them to “pad” their progress (if they did not perform enough of a desired behavior to meet their goal). A detailed account of this work can be found in [1].

3.1. Field Deployment

To assess the effect of our lapse-management approach on behavior and participation, we conducted a two-week field deployment of a real-world behavior-change program. The criteria for selecting a behavior-change program for the trial was (a) that behavior is tracked automatically (rather than relies on journaling), (b) that users have measurable daily goals, and (c) that, even in a short duration, users are likely to exhibit lapsing. We chose a behavior-change program that relates to productivity, designed for people who wish to reduce the time they spend online on a particular website (e.g., social media, news, or other leisure-based websites). We used a two-condition, between-subjects design to compare the online behavior and lapses of users in a Lapse-Management condition who received cheat minutes to users in a Control condition who did not.

(1) Plugin & Database

We implemented a custom plugin for the Google Chrome™ browser. The plugin is able to log and visualize time spent on a user-chosen website relative to a selected daily goal. Upon installing the plugin, the user first chooses a website they want to reduce their time using (we will refer to this as their “vice website”). The user then selects one of seven possible daily goals (0 to 30 minutes in 5-minute increments). Finally, the user chooses whether to track their vice website visits all day (24 hours) or only during work hours.

During use, the plugin tracks (and logs on our server) attempts to go to the vice website either by entering a URL or by bringing a browser tab with the site to the foreground. Instead of the vice website, the plugin first displays a Dashboard (see Figure 5). The dashboard contains buttons for the user to choose to either proceed to their website or not. If the user proceeds to their vice site, their time is logged on our servers. If, during their time on the vice site, they reach their daily goal, they are automatically forwarded to the dashboard. As before, they can then choose to return to their vice site or not.

The dashboard also contains information about the current-day’s time spent on the site and information about the previous 4 days. The background color for each day conveyed whether the user spent less time than their goal (green) or exceeded their goal (red). A gold star was awarded for days where the goal was achieved, and a red X otherwise.

3.2. Evaluation

We created two versions of the dashboard, one for each condition, as follows: In the Lapse-Management condition, starting on the second day of the deployment, users were granted cheat minutes totaling 20% of a daily limit every other day. Cheat minutes expire every two days, whether the user used them or not (i.e., no “rollover” of cheat minutes). Users in this condition were instructed how cheat minutes work in both the instructions and in the dashboard interface itself. The decision to have cheat minutes awarded every other day (and expire) was so that they do not simply become a user’s secondary goal.

The dashboard for users in this condition contained a designated button that had to be clicked in order to use the cheat minutes (see Figure 5, right) as well as information about cheat minutes used and cheat minutes remaining. If a user stayed under the limit thanks to using cheat minutes, the gold star that

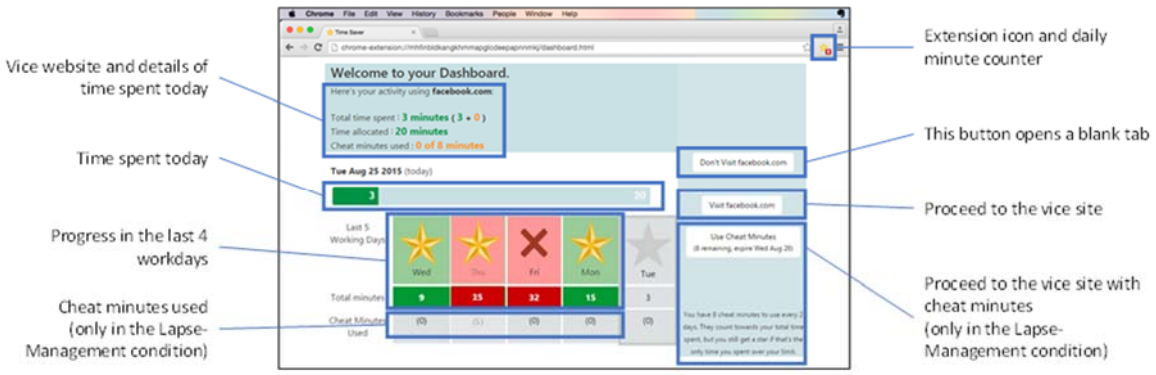

Figure 5. Dashboard of our custom browser plugin

they were awarded appeared on top of a red background (as seen in the second day in the dashboard in Figure 5). Users were redirected to the dashboard if they used up their cheat minutes. Users in the Control condition did not get cheat minutes. Their dashboard did not contain any mention of cheat-minutes, and included only a single button for proceeding to the website.

(1) Compensation

To ensure that continued participation in the deployment was not driven by money, users were compensated for the entire deployment at the end of the first day of participation. Those who chose to withdraw at the end of the first day received a $5 gift card, and those who chose to continue received a $15 gift card. This approach intentionally did not prevent users from dropping out of the deployment before the end of the 2 weeks (they were told they could withdraw at any time by uninstalling the browser plugin).

(2) Users

30 individuals participated in the deployment (16 women, 9 men, 5 did not disclose) and were assigned at random to the Lapse-Management and Control conditions (15 users per condition). Of the 30 users, 23 (77%) chose to reduce time on Facebook, two chose reddit.com, and the remaining five chose BuzzFeed, hulu.com, Gmail™, Pinterest, and a personal livejournal.

Users selected a wide range of daily goals. Twelve of the users wanted to reduce their time on the site only during workhours. The remaining wanted to reduce usage throughout the day. There was no statistical difference between the two conditions in the daily limit they set ($F[1,29]=0.24$; $p=.6$, n.s.).

(3) Results

On average, users visited their vice websites 85% of the days they participated in the deployment (238 days total) spending a grand total of 62 hours on the different vice sites (16 minutes a day, on average) in 2327 visits (9.7 visits per day, on average). To understand the effect of lapsing (exceeding one's daily limit) and the value of lapse management we first examine lapsing occurrences and users' attitudes towards lapses. We then examine overall differences between the conditions. Finally, we investigate users' use of cheat minutes and their impressions of the use of cheat minutes in behavior change. We quote users' responses to the end-of-study survey with LM1-LM15 and C1-C15 for users in the Lapse-Management and Control conditions, respectively.

Exceeding the Daily Limit (Lapsing)

During the deployment, 18 of the 30 users exceeded their time limit at least once: 11 users in the Control condition lapsed 30 days (out of 128 days), and 7 users in the Lapse-Management condition lapsed 17 times (out of 110 days). In five of these 17 lapses, using cheat minutes helped users still receive a star. The remaining users did not exceed their daily time limit. When asked at the end of the deployment to describe how they felt about exceeding their daily limit, attitudes varied from neutral (e.g., "Annoyed me but didn't particularly make me want to do better the next few days." <LM11>) to negative (e.g., "I tried to avoid using Facebook after exceeding the limit." <C13>, and "looking at that big red block was pretty guilt-inducing so I didn't do it again!" <LM14>). One user expressed the risk of tracked lapses, "Going over limit made me care less about going over in future." <LM3>.

Time Towards (and Past) a Goal

To identify differences between the Lapse-Management and Control conditions, we examined all days where users visited their vice site (N=238). We compared the time users spent on the site relative to their daily limit. (In order to avoid giving unfair advantage to the Lapse-Management condition, we count all time spent on the site, regardless of whether cheat minutes were used.) Before analysis, we excluded 3 days from user <C13> where they spent over 1 hour and 50 minutes on Facebook (with a daily limit of 30 minutes). We conducted a mixed effects model with Time Left at the end of the day (relative to each person's goal) as the dependent measure.

The analysis found that users in the Lapse-Management condition had more time left at the end of the day than users in the Control condition ($F[1,27]=4.21$, $p<.05$). Daily Limit had only a marginally significant effect with more time left at the end of the day with higher goals. To better understand this difference, we repeated the analysis, adding a Boolean variable labeled Lapse, indicating whether the user exceeded their daily goal or not, and the two-way interaction Lapse x Condition.

The difference for Condition was again significant indicating that, on average, users in the Lapse-Management condition had 3:54 minutes left at the end of a day, while users in the Control condition had exceeded their goal by 4:18 minutes (see Figure 6). This finding is especially interesting given that, technically, users in the Lapse-Management condition were "allowed" to use their vice site more and still receive a star.

The interaction was also significant ($F[1,225]=8.1$, $p<.01$) and showed that when going over the limit, users in the Control condition tended to go over their limit by a significantly greater amount than users in the Lapse-Management condition (18 minutes over vs. 5 minutes over, on average). This result

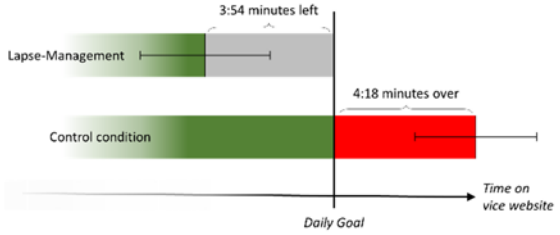

Figure 6. Lapse-management helped users achieve their goal

suggests that while cheat minutes did not always prevent lapses from occurring, they nevertheless lessened the amount by which people over-shot their stated goals.

Using Cheat Minutes

Six of 15 users in the Lapse-Management condition used cheat minutes. One user used cheat minutes 5 times, one user used them twice, and the remaining four used them once, for a total of 11 days. Users used all their cheat minutes only twice. Recall, that users in this condition only got cheat minutes every other day.

When asked about their use of cheat minutes, users' attitudes ranged from feeling guilty to positive. For some, using cheat minutes was seen as something to avoid. As stated by LM14, "I only really used the cheat minutes once but it was to contact someone for a work-related purpose who I know sits on FB chat all day. Otherwise, I felt guilt using the cheat minutes, which is something I really need!" Succinctly expressed by LM11: "It felt like, well, cheating." For others, cheat minutes were seen as useful: "The cheat minutes helped me to feel like I'm still minimizing my interaction with the site and staying on the goal while also being realistic about my ability to be distracted and occasional need to use the platform for work" <LM14>.

Having, but Not Using Cheat Minutes

We were also interested in understanding users in the Lapse Management condition who never used their cheat minutes. Some expressed that having the cheat minutes, even without using them was positive. For example, LM15 stated, "It was good to have the cheat minutes because they provided a safety net for my 20 minute goal." Finally, for some, not using available cheat minutes was "sort of like a reward" <LM1>.

Taken together, these responses indicate that overall Lapse Management was good for those who used it for sporadic (and sometimes unexpected) extra website use needs. At the same time, we also saw that simply having cheat minutes available was seen as a reassuring safety net; their mere availability did not necessarily mean people would use them to go over their limit.

Cheating without Lapse Management

Finally, we examined responses from users in the Control condition who did not have cheat minutes. The desire to have the plugin represent a goal being met led some users in the Control condition to increase their use of other means (such as their smartphone) to spend time on their vice site. For example, "I spent less time on Facebook as I became aware of it. I more carefully used my 20-minute daily allotment. However, I did start accessing Facebook on my phone, which I previous didn't really do, but it wasn't during "real work" time - it was in the bathroom (gross, I know!) or while commuting on public transportation. I still wanted to use Facebook, so I guess I found better times to do it on the mobile device." <C7>.

These statements illustrate that users wanted to be compliant with the time limit goals they had set. However, in the absence of any system-driven or "authorized" mechanism to manage lapses, they elected to lapse outside of the tracking environment by circumventing the dashboard and accessing their site of choice via other, non-tracked means such as on their mobile phone. In other words, without "cheat minutes," users appeared to be more likely to "cheat the system", resulting in a log that does not properly capture their behavior.

4. Future Directions

The work presented in this paper highlights technological opportunities for improving workplace wellbeing and productivity. Our work on work-breaks directs our attention to the need for sensing stationary and mobile activities, sensing movements, intent, and mental states. As a first next step, we are pursuing a system that combines on-body sensing, mobile device sensing, and indoor localization. We believe that such combined infrastructure can be the foundation of a wide range of applications tailored for the workplace for both individual and group interactions. For example, such sensing can be used to detect a person's movement (e.g., getting up from one's desk and leaving a room) and encourage short, indoor physical activities to improve wellbeing.

Our investigation of mechanisms to improve sustained behavior change can be applied to a broad-range of applications and need to be extended to cases of group activities, both collaborative and competitive.

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