Effects of Individual Differences in Blocking Workplace Distractions

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ABSTRACT

Information workers are experiencing ever-increasing online distractions in the workplace, and software to block distractions is becoming more popular. We conducted an exploratory field study with 32 information workers in their workplace using software to block online distractions for one week. We discovered that with online distractions blocked, participants assessed their focus and productivity to be significantly higher. Those who benefited most were those who reported being less in control of their work, associated with personality traits of lower Conscientiousness and Lack of Perseverence. Unexpectedly, those reporting higher control of work experienced a cost of higher workload with online distractions blocked. Those who reported the greatest increase in focus with distractions blocked were those who were more susceptible to social media distractions. Without distractions, people with higher control of work worked longer stretches without physical breaks, with consequently higher stress. We present design recommendations to promote focus for our observed coping behaviors.

Author Keywords

Distractions; workplace; social media; focus; interruptions; multitasking; field study; productivity

ACM Classification Keywords

H.5.3 [Information Interfaces and Presentation (e.g., HCI)]: Group and Organization Interfaces; K.4.m [Computers and Society]: Miscellaneous.

INTRODUCTION

Information workers are experiencing increasingly more online distractions. Distractions from media have long been a topic of interest in the HCI research community and have been studied from the perspectives of interruptions and task-switching, e.g., [6, 8, 10, 24, 25, 36, 41]. A study by Salary.com found that in 2014, 89% of information workers reported that they are distracted daily by non-work related sites, the clear majority of which were social media [19]. While social media certainly can be used for work activities and can provide benefits in the workplace, in the same study, nearly all of these users claimed that they wasted over thirty minutes daily in nonproductive online activities, taking time away from their work.

A number of solutions for controlling distractions have been proposed, drawing on work in HCI such as using appropriate timing and mode of the presentation of interruptions [23, 27, 30, 39]. In addition, a number of commercial solutions have appeared, promising increased focus through shutting off or reducing distractions from notifications and/or social media [e.g., 11, 14, 15, 16, 47, 49]. While many approaches assume that blocking distractions is beneficial, this may not be the case for all: some users may incur costs when distractions are blocked, especially based on research that shows the need for replenishing mental resources, which workbreaks can provide [50]. Studies also show that people can adapt to distractions, e.g. [46]. Distractions from phones also show unclear effects: shutting off notifications revealed positive effects (feeling less distracted) as well as negative effects (feeling less connected) [43, 44]. Thus, it is not clear based on the literature that blocking distractions will indeed benefit people in real-world settings – which is the goal of this study. We hope to address this gap in the research through understanding how well such blocking approaches work, and how users react to these approaches.

In this current paper, we examine this question and report results from a field study with information workers where a software tool was deployed that blocks online non-work related distractions in the course of a user's actual work. To our knowledge, this is the first study that has explored the costs and benefits of introducing software to block distractions in the workplace. As a first step, we present an exploratory study of 32 information workers where we examine the user perspective of how lowering workplace distractions might affect information work. Our goal

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ultimately is to understand how we can achieve better work practices in a technology-mediated environment.

WORKPLACE DISTRACTIONS

Our study is motivated by a long history of research in HCI. The role of workplace distractions has been unclear since research shows that distractions incur both costs and benefits--e.g., see [8]. With growing practices of multitasking in the workplace, a large body of prior work has focused on how multitasking impacts attention in the workplace, primarily focusing on the distraction caused to an ongoing task that is interrupted by another activity. From a workplace diary study, Czerwinski et al. [8] showed how information workers face difficulty due to the continuous switching of context from interruptions. External interruptions cause information workers to enter into a 'chain of distraction' where stages of preparation, diversion, resumption and recovery take time away from an ongoing task [24]. Many interruptions involve "interruption residue" [29] even after an interrupted task has been resumed, adding mental load to an information worker.

Evidence shows that people adapt to distractions, without having to eliminate them. Workplace studies have shown that people adjust their work practices to manage constant face-to-face interruptions, [46] as well as computer-mediated interruptions [51]. While these workplace studies have examined work-related interruptions, fewer studies have addressed non work-related interruptions in the field.

Both non-work as well as work-related distractions can also provide benefits. Previous studies have identified that users have used a variety of sites--news sites, Facebook, Pinterest, Instagram, shopping sites and other kinds of non-work related applications, to escape from the demands of highly focused work and to "self-stimulate" themselves [25]. Work breaks like walking outside have been shown to provide benefits for being more creative at work [1]. Of course, the workplace also includes external interruptions from colleagues, family and friends, instant messages, phone calls and email.

A recent Pew Research study reported that benefits of workplace social media use include taking a mental break from work, connecting with friends and family, and connecting with others professionally [40]. However, 56% of these employees reported that social media distracts them from their work, with 30% agreeing strongly. Other costs are that increased information technology use leads to too much time at the desk [48]. Over half of employees surveyed in the Pew report describe that their workplaces have policies that regulate the use of social media at work [40]. These policies do have mixed effects though, with fewer people able to use social media to take a mental break, and to find work-related information.

Distractions can create other costs. Laboratory studies have consistently shown that attending to distractions increases cognitive load (see [28] for a review). When distractions were introduced in a simulated work environment, perceived cognitive load, including time pressure, increased [36]. Notifications on phones are shown to be associated with inattention [26]. In the field, switching tasks on the computer has been associated with higher stress [33]. Thus, while research has consistently shown an association of dealing with distractions and increased cognitive load (mostly in the laboratory), to our knowledge, no study has shown how cognitive load is affected in a real work environment when distractions are removed.

While the term "distractions" may have a negative connotation, we use it in this paper with a neutral sense to refer to the use of information technology during work time that leads someone to switch their attention to an online site or application that is not directly related to work. While social media and online micro-breaks may provide numerous benefits in the workplace, others have argued that they create challenges through switching contexts, e.g. [8]. We thus use the term distractions merely as a referent, knowing that they have both benefits and costs.

Approaches to blocking online distractions

Adaptivity (i.e., using machine learning to understand a user's rhythm of work) notwithstanding, there are two basic approaches used to block online distractions. The first is indirectly through increasing user awareness by presenting users with analytics of how much time they have spent on various sites such as productivity apps, social media, email, and other Internet sites. Commercial products of this type include, e.g.: Delve Analytics [11] Focus [14], Focusbooster [15] and RescueTime [47]. The prototype meTime was shown to reduce the time spent in noncritical activities [52].

A second approach is by filtering or blocking sites and applications that can distract from work. Again, commercial products exist, such as Stayfocused [49] or Freedom [16]. These types of apps allow users to set times and preferences for those sites that they want to block. The Pomodoro technique [45], a popular method that helps users more effectively regulate their time, does not block distractions.

Thus, while it has been investigated how undesired notifications can be blocked and filtered, e.g. [38], and how making users aware of their computer usage provides benefits, [52] there is a lack of research on how filtering potential distractors for self-interruptions affects people's focus, productivity, and workload. We address this gap in this study by deploying an off-the-shelf software tool to block non-work-related online distractions of the user's choosing.

RESEARCH APPROACH

Our overarching research question is: *What are the costs and benefits of blocking distractions in the workplace? Are there individual differences in experiencing such costs and benefits?* Based on past studies of how distractions affect work, we decided to examine the measures listed below. As

this is an exploratory study, we also discuss our rationale for selecting our measures.

Focus and engagement in work.
Blocking workplace distractions might entail a benefit of increasing engagement in work. Engagement involves deep interest and attentional focus in a task [51]. Current theories of attention propose that people have a limited capacity for attentional resources [54]. Distractions potentially draw attentional resources from a pool of resources available to maintain attention on other tasks. Thus, with fewer distractions, people should have more attentional resources available to devote to the current task-at-hand and it should take less effort to maintain higher focus in their work.

As the workplace is dynamic, we measure a state of engagement that can change, known as cognitive absorption [2]. We chose to use the Cognitive Absorption scale theorized by Agarwal and Karahanna [2] to measure states associated with deep engagement in an activity. These states are: *Focused immersion*: when people are deeply focused in an activity, they experience total engagement, and can disregard other factors that compete for attention; *Enjoyment in work*: focused attention has long been associated with positive emotions, e.g., [2] and people in a state of cognitive absorption report heightened enjoyment in their activity [7]; *Temporal dissociation:* theories of deep immersion propose that when deeply focused, people become temporally dissociated with the environment, i.e. unaware of the passage of time [2, 7]; *Control:* cognitive absorption is associated with a feeling of being in control of the situation [7]; and *Curiosity*: when people are deeply immersed in an activity, they also can become excited, curious, and focused, to discover more about that activity.

Productivity
Another potential benefit of blocking distractions is that individuals (and teams) may feel more productive. Tasks that get interrupted have been shown to take longer to complete compared to tasks that are not interrupted [3, 17]. Distractions could also detract from productivity due to interruption residue, where the content of the interruption remains in memory and can interfere with the current task-at-hand [29]. With fewer distractions, and thus increasing the time and focus on the task, people may perceive they are more productive. On the other hand, social media, a large part of workplace distractions, can provide benefits for productivity. For example, people can take digital breaks when they feel less productive [13]. While online digital breaks could help people refresh, too many digital breaks and for too long, could take time away from core tasks.

Productivity has long been a challenge to measure in information work. Measuring "output" is a slippery slope. For example, measuring lines of code is not adequate to assess productivity in software developers. Performance reviews can also be subjective, and as they are done annually or bi-annually, they would not capture the granularity of a shorter time period. To our knowledge, there is no good objective measure of productivity available for information work. We therefore chose to measure information workers' self-assessment of productivity, with an index used by [31] and which shows face validity. This measure is comprised of six dimensions concerning accomplishment, efficiency, satisfaction, effectiveness, quality and overall assessment of work.

Workload
Blocking distractions could affect workload. Interruptions, particularly lightweight activity such as social media use, could reduce workload through breaks [34], enabling people to refresh mental resources. Without an outlet to refresh, cognitive burden might accumulate.

On the other hand, introducing interruptions into a simulated work environment in the laboratory caused the experience of workload to increase [36]. People need to invest attentional resources in managing interruptions. With distractions blocked, and more resources freed up to devote to a work activity, this could lighten the cognitive load. Also, without online distractions, people might reconfigure their work patterns to take different kinds of breaks such as taking a walk, which can significantly increase convergent thinking [1].

We use the NASA TLX scale [20], used previously to measure the workload of interruptions [36]. The NASA TLX scale is a well-validated measure of workload in six dimensions: mental demand, physical demand, temporal demand, performance, effort and frustration.

Individual differences in tolerance to distraction
Costs and benefits of experiencing reduced distractions may depend on how susceptible a person is to distractions. The workplace contains a multitude of different types of distractions (e.g., email, texting, phone, face-to-face encounters). Ophir et al. [41] discovered that individual differences exist with people's ability to filter out peripheral stimuli in the environment such as notifications. This suggests that individual differences may exist in the susceptibility to various kinds of distractions. To measure individual differences in reaction to distractions, we asked people to rate the extent to which they felt distracted by different types of workplace distractions.

Personality
Research has shown that personality affects focus [32]. To explore the role of individual differences when distractions are reduced, we also included the Big 5 personality survey [37]. In particular, we wanted to explore whether the trait of Conscientiousness, associated with being vigilant, might affect a person's ability to filter out distractions. A highly Conscientious person may not have a need for software that blocks distractions. We also included the UPPS Impulsivity scale [53] which enabled us to explore traits that could be related to distractibility: *Urgency,* the tendency to act on strong impulses, *Lack of Perseverance*, the inability to

persevere on a task, and *Lack of Premeditation*, the inability to plan before taking action. Impulsivity has been tied to focus ability in the workplace [32].

User perspective

To gain the user perspective, we interviewed participants after their workplace experience with distractions blocked.

METHOD

We conducted a field study and recruited 32 participants (15 females, 17 males). One participant was discontinued from the study as she stopped coming to work and was unreachable. We thus used 31 participants in our analysis. We recruited volunteers through email advertising. Participants were all information workers in a large U.S. west coast corporation, in varied job roles: administrative assistant, researcher, technologist, and manager. Participants gave informed consent, were assured that their data would be kept anonymous, and were given a $250 gift card at the end of the study.

The study lasted two workweeks (10 days) with two conditions as follows:

Week 1: Baseline. In the first week, participants were instructed to work as they normally would, with full use of their computer and phone.

Week 2: Blocking non work-related sites. In the second week, participants were also instructed to work as they normally would except that we used software to block sites that were nonessential for work during work hours.

As the costs and benefits were unknown, and as cutting off non-work related sites could potentially be quite disruptive for some people, we felt that a cutoff period of one work week would be reasonable. It would enable us to gain the user's experience from a sample of five days without potentially disrupting work too much, similar to the reasoning used in a study of cutting off email for five work days [35] and mobile phone notifications for 24 hours [44]. Two participants had a time gap of one week and two weeks, respectively, between their baseline and intervention weeks due to their schedules.

At the beginning of week 1, we met participants individually and explained the study procedure: they were told that in the first week they should work as they normally do and in the second week they would use blocking software. The second week was identical to the first, except that we asked participants to set up the blocking software to block the non-essential sites for the week and that their personal cell phones not be used during work. Participants filled out daily and weekly surveys and were interviewed about their experiences.

Blocking non-essential websites

Participants installed Freedom software [16] that blocks websites on their computer. The default setting includes a blocklist of 22 sites which is mainly comprised of social media sites like Facebook, Instagram, Youtube, Reddit, and Twitter, etc., but also Amazon, eBay, and news sites. Participants were instructed to add sites to this list that they might potentially check over the week that were nonessential to work. We made the explicit decision to allow participants to choose which sites to add to the default list, as they were better aware of what sites distracted them and also so that they would control what sites to block. Freedom software does not allow webpages to load that are on the blocklist.

Freedom software is available for ioS but not for other smartphone platforms. Because our participants had different types of smartphones, in order to achieve a uniform condition across all participants, rather than install the Freedom on phones for just some participants, we asked everyone to put their smartphone away in a drawer or bag and to use it only for essential communication during work hours. Participants were told they could use their phones before and after work, and during their lunch breaks. In the interviews, we asked participants about their compliance.

Freedom software has a locked mode where blocking sessions cannot be disrupted. Participants were instructed to set a clock on the Freedom software to begin blocking sites before they came to work and to end blocking after they left the workplace. They were instructed to set the times to be re-occurring so that blocking would automatically start at the designated time each day. Only computers at the workplace and during workplace hours were blocked, and not home computers, i.e. not in the evenings at home. Thus, participants could look at whatever websites they chose before/after workplace hours and during their lunch break.

Because email is essential for work, participants' workplace email client was not blocked. Their personal gmail accounts were blocked. However, since participants could potentially receive personal emails in their work accounts, personal email could not be guaranteed to be fully blocked.

Measures.

We describe more details of our measures as follow.

Focus and engagement was measured by the Cognitive Absorption (**CA**) scale, a well-validated scale to assess focus and immersion with digital media experience [1]. This scale measures five dimensions on a 7-point rating scale (1=low, 7=high): *Focused immersion (5 items)*; *Enjoyment in work (4 items)*; *Temporal dissociation (5 items); Control (3 items);* and *Curiosity (3 items)*. To compare the effects of the blocking software, the CA was administered at the end of the Baseline week and the end of the Blocking week. Participants were instructed to respond based on their experience over the last five days. An example of items were: *(Focused Immersion)*: *I am immersed in the task I am doing; (Enjoyment): Using the computer provides me with a lot of enjoyment; (Temporal dissociation): Time flies when I am using the computer; (Control): When using the computer I feel in control; and (Curiosity): Using the computer arouses my imagination.*

These separate constructs were shown to have high discriminant validity, i.e., they are not correlated and measure different concepts.

Productivity was measured at the end of each day by an index comprised of six dimensions: *"How much did you accomplish today based on what you had planned to accomplish?", "How efficient do you feel you were today in performing your work?", "How satisfied were you in what you accomplished today?", "How effectively do you feel you managed your time today?", "How would you evaluate the quality of the work you did today?",* and *"Overall, how productive do you feel you were today?"*. The questions used a 7-point rating scale: 1=not at all, and 7=extremely.

Workload was measured at the end of each day by the NASA TLX scale [20].

Susceptibility to distraction was asked in the General Survey, administered at the beginning of the study using a 7-point rating scale (1=not at all; 7=extremely): *In general, in a typical day how distracted do you feel by: social media, email, face-to-face informal workplace interactions, notifications, text messaging, and phone calls.* The Big 5 Personality Survey [37], the UPPS Impulsivity scale [53], and demographic information were also measured in the General survey.

At the end of each day, participants reported if that day was a typical work day or not, and if any unusual circumstances occurred that might affect their results.

Post-study interviews. At the end of the study period, semi-structured interviews were done and participants were asked about their compliance with using the Freedom software, their phone use, and their experiences with productivity, stress, focus, self-interruptions, and experiences with the software itself. Interviews ranged from 20 minutes to an hour. Interviews were recorded and transcribed and open coded to discover themes.

RESULTS

In addition to the default list of 22 blocked social media, news, music and commercial sites that Freedom's software provides, some users added additional personalized sites that they viewed as distractions, e.g., google.ca/finance, indeed.com, ufc.ca, alltrails.com, newsru.com, washington.edu, washingtonpost.com, slickdeals.net, and wta.org. All participants blocked social media sites. Approximately 59% of the sites blocked were social media.

At the end of the study, in the survey, participants were asked if blocking websites that were potential distractors provided more costs or more benefits for them. Responses were: 17 reported 'more benefits', 10 reported 'more costs', and 4 reported 'neutral'. These conflicting reports suggest individual differences that can be further explored.

In the interviews, we asked about compliance with the study, in using the software and with not checking smartphones. We asked participants to report on a scale of 1 [did not comply at all] to 7 [fully complied]. The mean response was 5.8. All complied with running the Freedom software except for two participants. One uninstalled the Freedom software, as it automatically blocked some sites that were essential to work and he reported that he kept with the spirit of the study and did not check social media or other nonessential work sites during the week. The other installed Focus for Chrome (similar to Freedom). For other participants, the less than full compliance was primarily due to phone use. The modal response for phone compliance was 6, and most of these participants reported checking their phone only several instances throughout the week. Thus, most participants complied moderately to highly with the study and lapses were due to checking phones, usually several times in the study week.

As an overview, many participants reported that by using the software, they gained a greater awareness of how distracted they were during the workday, represented by these participants' explanations:

P32: It was actually quite nice to be made consciously aware of what I was doing instead of a habit of going to a site and checking things that may not be quite useful.

P13: The single biggest thing I noticed was my fingers sort of habitually typing in Facebook.com.

Focus and Engagement

Our first analysis examined if focus and engagement in work increased when online distractions were reduced based on the Cognitive Absorption (CA) [2] dimensions. Results of a paired t-test of the Blocking week compared to the Baseline week are shown in Table 1. Participants judged themselves to have significantly higher Focused Immersion. They also reported significantly less Temporal Dissociation and lower Enjoyment in work in the Blocking week, which we address later in the paper. Control and Curiosity did not change. We return to the Control result in the next section.

Our interview results helped shed light on why participants reported higher focus (Focused Immersion). First, the blocking software reduced interruption residue [29], where effects of an interruption or prior task remain with an individual, even after the task is no longer being worked on. Participants described that in Baseline they had difficulty in "resetting" or resuming work as they would continue to

CA dimensions	Total (SE) Baseline	Total (SE) Blocking	t(30)	*p*
Focused immersion	22.94 (1.0)	25.71 1.04)	2.80	.01
Temporal dissociation	26.13 (.70)	24.32 (.91)	-2.85	.008
Control	10.29 (.37)	10.52 (.38)	.54	.60
Enjoyment	20.00 (.79)	18.32 (.86)	-2.19	.04
Curiosity	9.39 (.41)	8.94 (.39)	-1.24	.23

Table 1. Paired t-test results (Blocking - Baseline) of Cognitive Absorption subscales: Focused immersion, Temporal dissociation, Control, Enjoyment, and Curiosity.

think about the distraction even when they switched back to work. Thus, the distraction content can interfere with one's focus. P17 represents this view:

I kind of started realizing only last week [week 2] when I was blocking, that time doesn't remain in the 10 minutes [of being in Facebook] like if you say I'll just drop in for 10 minutes even if you close that you don't really come out of that zone; and to get back to what you were doing it would take a little bit longer; so that would typically increase the time to do something.... but after leaving the website [referring to social media], the concept remains in one's head and it takes longer to resume work.

Another theme that emerged is that the software supported focus by preventing chains of distractions, referred to as "*rabbit holing*" or "*falling into a spiral*". This phenomenon has also been documented in prior work [24]. As some participants reported:

P13...killing that meant it would keep certain chains of distraction from cascading. When my head gets a little tired then I go and open Facebook, then read a message or two, and that would often lead to an article, and then I would write a rant; and that's 5 or 7 or 10 minutes. Having it off meant that that cascade would stop.

P11: I tend to rabbithole. It was helpful to not have that distraction. It also made me realize how much I might be reaching for it; I'd be doing it and then thought right I can't do that right now. Definitely noticed a difference.

Control

While we found no differences in Control in the CA scale, the interviews revealed a common theme that people differed in their ability to control their distractions. For example, some participants explained that they had strong self-control over distractions and regarded the software as unnecessary. Six even expressed that they disliked that the software was controlling them, e.g.:

P5: I can already shut out non-essential work sites myself.

P2: I like being in control; I don't want it telling me what to do; what is work or not is my choice.

Others reported having little self-control and found the software helped them curtail their urge to distract themselves. Some representative comments are:

P32: Not sure I would have the self-control without the software; once I got to the block page I could go immediately back to work.

P17: [with the software]: I felt more in control of what was going on and less overwhelmed.

We wanted to investigate these differences further. The interviews led us to hypothesize that the measure most related to the ability to self-control distractions was the Control measure in the CA scale. We expected that people who already have high control over their work may not further benefit with online distractions blocked. On the other hand, those with low control over their work should benefit the most when online distractions are reduced.

We chose to analyze the baseline Control measures of the CA scale, as they should represent more accurately people's actual ability to self-regulate attention prior to the blocking intervention. Based on the response distribution, we divided the participants into two groups: those scoring low in Control: 14 participants, (mean=8.50, sd=1.61) and those scoring high in Control: 17 participants (mean=11.76, sd=.75). We confirmed that the scores of these two groups are significantly different ($p<.001$) using a Mann-Whitney U test, as the baseline Control distribution was non-normal.

We next hypothesized that because the personality trait of Conscientiousness is associated with self-discipline and diligence, it should be related to high control. We found that people's Conscientiousness scores were significantly positively correlated with their baseline CA Control scores, $r=.47$, $p<.008$. A t-test confirmed that those in the high CA Control scoring group were significantly higher in Conscientiousness (mean=34.59, sd=5.86) than those in the Low CA Control group (mean=29.43, sd=6.64), $p<.03$.

Last, we expected that the CA Control scores would be associated with an impulsive personality. Specifically, we expected that the lower one scored in CA Control, the more impulsive one should score on the UPPS impulsivity scale. We did find that CA Control scores were negatively correlated with the trait of Lack of Perseverence (UPPS scale), $r=-.50$, $p<.004$, and a t-test confirmed that those in the low CA Control group scored significantly higher in Lack of Perseverence: (mean=40.12, sd=5.27) than the high CA Control group: (mean=34.36, sd=6.36), $t(29)=2.71$, $p<.01$. The other two dimensions of impulsivity were not significant.

For the rest of the paper, we refer to the CA Control score as 'Self-Control': the group scoring low in CA Control at baseline is referred to as the 'Low Self-Control' group and the group scoring high in Control at baseline as the 'High Self-Control' group. While the construct of self-control can also be correlated with other measures that we did not test,

	mean (sd) Baseline	**mean (sd) Blocking**	
Low Self-Control	8.50 (1.61)	9.79 (1.81)	
High Self-Control	11.76 (.75)	11.12 (2.20)	
Mixed ANOVA analysis:			
Factors	**F**	**df**	**p**
Within-subjects: (Baseline-Blocking)	.66	1, 29	.42
Between-subjects: Low/High Self-Control	24.94	1, 29	.001
Within Ss (Baseline-blocking) x Between Ss (Low/High Self-Control)	6.08	1, 29	.02

Table 2. Means of Low and High Self-Control, and mixed ANOVA analysis.

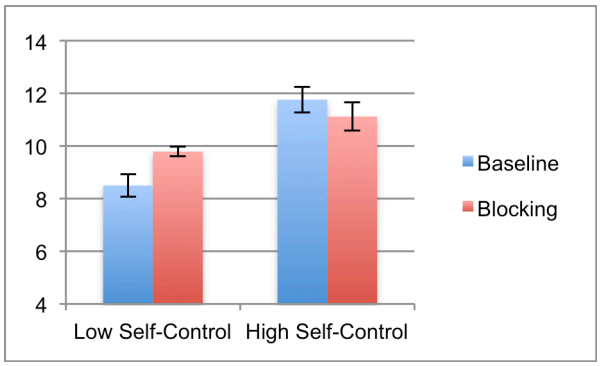

Figure 1. Means (SE) of Low/High Self-Control groups in Baseline and Blocking conditions.

it is associated with the constructs of Control, Conscientiousness, and Impulsivity [12], as we found. We stress that our use of the term Self-Control is merely used as a referent in this paper.

We conducted a mixed ANOVA analysis in SPSS comparing the CA Control scale repeated measures at Baseline and Blocking, and Self-Control (low/high groups) as the between-subjects variable. The results in Table 2 showed that the between-subjects factor of Self-Control (low/high) is significant. It also revealed a significant interaction as shown in Figure 1: those in the low Self-Control group at baseline significantly increased their score with the blocking software, whereas those in the high Self-Control group at baseline did not change their reported scores in the blocking condition. Note that the possible score range was 3 to 21, so a ceiling effect did not occur with the ratings.

These results suggest that people who already possess higher self-control (as measured by the CA Control measure at Baseline) did not change their sense of control when online distractions were blocked. Our data suggests they can be characterized as having personality traits of being more conscientious and having greater perseverence. However, people who possess low self-control increase their sense of control over work when distractions are blocked. We further examine the variable Self-Control in the following analyses.

Perceived Productivity

The productivity measure, which asked participants to assess productivity on six dimensions using a 7-point rating scale, showed that the six dimensions were all highly and significantly correlated. Therefore, we created an additive index over all dimensions, where the summed productivity measure ranged from 6 to 42. The means (sd) for individual summed productivity assessment for Week 1 is 26.48 (.99) and for Week 2 are 30.29 (.98). We conducted a mixed ANOVA analysis in SPSS with Productivity as the within-subjects factor (comparing Productivity scores at baseline and blocking) and Low/High Self-Control as the between-subjects factor. Table 3 shows that perceived Productivity significantly increased with distractions blocked and the high Self-Control group is significantly higher than the low Self-Control group. There was no significant Productivity by Self-Control interaction.

Factors	F	df	p
Within-subjects: Productivity	13.97	1, 29	.001
Between-subjects: Self-Control (L/H)	14.51	1, 29	.001
Productivity x Self-Control (L/H)	.075	1, 29	.79

Table 3. Mixed ANOVA results of Productivity change from Baseline to Blocking.

The interview results revealed reasons why perceived productivity increased. Twenty-three participants described that they felt more productive the second week with nonessential sites cut off, ranging from 'just a bit', to 10%, to saving one hour a day. One theme that emerged is that work became less fragmented. Some participants described that they multitasked less. For example, P22 reported that he did less task-switching which was less disruptive. Twenty participants reported that they worked in longer chunks of time without getting distracted or taking breaks. As some participants expressed:

P9: Small and medium tasks moved to longer durations. I was spending more time on these things even though that wasn't in the original plan. While I'm doing this anyway, instead of doing a break, I thought let me go finish even though this wasn't planned.

P9: ...the time duration of focus increased.

P16: Yes, I was more productive this week. I'm thinking about something, then I get distracted, then I have to start over; but now I didn't have to take a step back and start over.... I think I was more deeply concentrated this week than previously; it was easier for me to concentrate more, I had more deep concentration for sure.

P30: Yes; it definitely made me more productive, I realized that I needed to concentrate on what was in front of me. Not having that [social media] access made me realize and go back to work.

Workload

Participants completed the NASA TLX workload scale at the end of each day. Combining all six workload items into an additive index, we conducted a mixed ANOVA analysis in SPSS with the within-subjects variable of TLX (comparing baseline and blocking), and the between-subjects variable of Self-Control (Low/High), with results shown in Table 4. The model showed no significant main

Factors	F	df	p
Within-subjects: TLX	2.98	1, 29	.10
Between-subjects: Self-Control (L/H)	2.28	1, 29	.14
TLX x Self-Control (L/H)	6.51	1, 29	.02

Table 4. Mixed ANOVA results of TLX change from Baseline to Control.

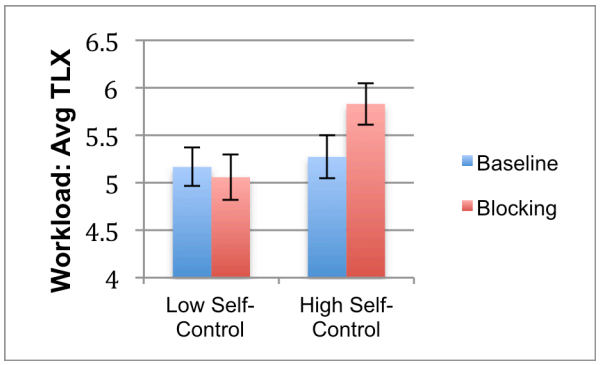

Figure 2. Means (SE) of TLX Scores of Low/High Self-Control groups in Baseline and Blocking conditions.

effects of TLX and Self-Control but did show a significant Self-Control x TLX interaction (Figure 2). The Low Self-Control group did not perceive a change in workload when distractions were cut off, but the High Self-Control group perceived a significantly higher workload when distractions were reduced.

The interview results can help interpret this result. In the interviews, 16 participants reported higher stress, due to being more focused and working longer stretches during week 2. Of these, 11 were in the high Self-Control group. Even though they could have walked out of the office for a break, they did not. One participant was so involved in work that she missed the last commuter shuttle back home--this never happened before. Being more tired in week 2 was a common theme in the interview data:

P21: Once I didn't realize how long I was sitting working; usually I take a break; cause there was nothing to stop me.

P9: Yes, I was 10% more productive, and more tired at the end of the day. I think it's the notion that I had the implicit urge to finish the project for what I set out to do--instead of a pause and take a break and come back; I worked relatively longer stretches, it was more tiring. I felt it more at the end of the day. There is no free lunch.

P23: It lets me focus on work more but then I'm not able to step back as easily. I didn't take breaks leaving the office and just ended up staying there.

Participants who described experiencing no difference in stress and workload were able to readjust or "rewire" themselves by changing the nature of their breaks to physical breaks of leaving the office. Nine participants reported that they took more physical breaks, getting out of their offices and walking more, getting more coffee or visiting others in their offices.

These reports could explain why workload increased for those with high Self-Control: they have the ability to be in control of when they take breaks. Cutting off access to online breaks made them work even harder since they possess traits associated with diligence (high Conscientousness and Perseverence). We found this to be a counter-intuitive, but very important finding for the design of technology to support workplace well-being.

Factor	Types of distractions
"Notifications"	Email, notifications, text messaging, phone calls
"Social Media"	Social media (positive loading), informal F2F interactions (negative loading)

Table 5a. Factor analysis results.

Independent variables	coeff	SE	t	p
"Notifications"	.26	.97	.27	.79
"Social Media"	2.70	.97	2.78	.01

Table 5b. Regression results with Focused Immersion as dependent variable, adj. R^2=.16. Participants reporting being

Tolerance for online distractions

Participants were asked about how distracted they felt by six different types of potential distractors, described earlier. We conducted a factor analysis to see if there was an underlying latent structure in the data. We used a Varimax rotation with a Kaiser normalization. A scree plot[1] revealed that we should use two factors, which explained 58.9% of the variance. Table 5a shows the variables that loaded onto the separate factors with our interpretations in the left column. Email, notifications, text messages and phone calls all loaded onto the first factor. As these all concern notifications, we label this factor "Notifications". On the second factor, social media loaded positively, and informal face-to-face interactions loaded negatively. This suggests that those susceptible to social media distractions perhaps feel they can control their informal face-to-face interactions. We label this factor as "Social Media".

The results suggest that different types of distractions might affect individuals differently. We investigated whether the blocking software (which blocked both social media and other sites) might be associated with an increase in focus, based on such differences. We next did a linear regression, regressing Focused Immersion from the CA scale on these two factors (Table 5b): $F(2, 28)=3.90$, $p<.03$. The results show that while the software blocked social media as well as other sites, those who showed the greatest increase in focus with the software were those who reported being more susceptible to social media distractions.

DISCUSSION

We set out to try to understand the costs and benefits of using popular software that blocks online distractions, and discovered individual differences. The benefits of blocking

[1] A scree plot is used to determine the number of factors based on showing when the curve flattens.

were observed for some users in terms of increased perceptions of productivity, increased focus and lower cognitive load. Those participants who benefited the most were those who felt they had less control in their computer work in baseline, were most susceptible to social media distractions, and who scored lower in personality traits of Conscientiousness and Perseverence. With distractions blocked, their cognitive load did not increase.

An attentional resources model [54] would explain this result as follows. The software blocks distractions which frees up attentional resources (i.e., that would ordinarily be used to attend to distractions, e.g,. social media). With available attentional resources, people can devote more resources to focusing on work.

Those who experience the most costs with blocking software are those who feel better able to self-regulate their distraction behavior, and who have personality traits of higher Conscientiousness and Perseverence. Their cognitive load increased when online distractions were blocked and interview data suggested that a reason is that they tended to work longer stretches without breaks. An interpretation is that online non-work related sites provide an easy break for those people with high self-control for how much time they spend in a break. As these individuals possess Conscientious and Perseverence traits, they worked longer without taking physical breaks. Thus, if an individual already has control in their work, the software does help with focus and productivity, but at the cost of higher cognitive load.

The CA scale result showed that people became less temporally dissociated, or more aware of time, when online distractions were blocked. Removing online distractions, which can serve as breaks, can make people notice more the passage of time. In the interviews, participants often described how in baseline, they would lose track of time when on social media sites. It is worth noting also that the subjective estimate of time duration increases as tasks become more difficult, [4, 5, 9]. While cognitive load increased for the high Self-Control group, future research could examine whether work was perceived as more difficult.

We interpreted the two factors that we discovered in our factor analysis as 'Notifications' and 'Social media'. While we did not block work email, a possible alternate interpretation is that the first factor could correspond to "external interruptions" and the second factor could correspond to "self-interruptions" as social media is generally checked by self-interruption. However, email could be a distraction either through notifications or by self-interruptions. In the general survey we asked participants if they used email notifications and 22 (71%) responded that they did. It is possible that the latent structure in the data represents two groups: those more susceptible to external distractions and those more susceptible to self-interruptions. Future research could examine characteristics of people more susceptible to external or self-interruptions, as this could impact the design of attention management systems.

When asked if they would continue using Freedom or similar software to block distracting sites, reactions were mixed. Twenty participants said they would use the blocking software in daily work, especially if it had the modifications they suggested. Five said that possibly they would use it. Six participants would not use it as they felt controlled or annoyed by it. Two participants continued to use the software after the study ended.

Reconceptualizing workplace distractions

It is important to consider that the costs and benefits of distractions depends on their situated nature: their timing, the source (Facebook vs. upsetting news), whether it is externally or internally driven, if the context is congruent with work activity, and as our study suggests, individual differences.

Our study found evidence that blocking workplace distractions provides substantial benefits in work with reported deeper focus and higher productivity. This finding builds on previous work where fewer interruptions have been shown to lead to higher concentration [22], and where shutting off mobile phone notifications led to perceived higher productivity [26, 43]. Being able to focus longer is a precursor to entering a flow state, which can lead to deeper engagement in a topic, higher quality work and even innovation [7]. Some of our participants indeed reported that they experienced more flow in the blocked condition.

Yet we also found that distractions can offer valuable functions in information work. They serve as a convenient way for people to take short mental breaks from work and to connect quickly to others to satisfy social needs. It is important to consider that breaks can also be habitual, and lack of self-control can interfere with work.

Our study provides more clarity on the role of workplace distractions: non work-related distractions, long considered a bane in HCI research, may actually play an integral role in the connected information workplace. We need not only consider properties of distractions to judge the costs and benefits (e.g., external vs. internal interruptions; social media vs. news) but also characteristics of the individual and the situated nature of the work itself.

Design recommendations: Users' perspectives

In the interviews, we asked participants, based on their actual experience of having online workplace distractions blocked, how a system could best support blocking online distractions and promote focus. We open-coded the responses and present the user perspectives.

Learning to gain control. We found that users had individual differences in their self-Control of work. Some users with low control (and low Conscientiousness) expressed that they wanted to *learn* to gain control of their work. The coding revealed three ways users felt software

could help. Some participants desired analytics so that they could see exactly how much time they were spending on various websites. This would enable them to self-adjust and could help inform them to set thresholds on how much time to spend on a site during work hours, e.g., Facebook. Some users expressed they wanted to be able to set goals with the software of how much time they would like to work uninterrupted. Users felt that in this way they could learn self-control over distractions and gradually reduce their dependence on the software. Still other users expressed that they could learn to change behavior if the software queried them, e.g., did they feel they were wasting their time at a particular site? Whereas some commercial tools exist that provide analytics, participants felt that a smart tool where they could learn to develop new behaviors would be useful.

Rhythms of attention focus. Some users expressed that the software should block them only at certain times, for example, when they are bored. Research shows that patterns of attention focus and boredom vary throughout the day and when bored, people can be more susceptible to distraction [33]. Some users felt that blocking should target classes of sites at particular times, e.g., entertainment sites after lunch when attention is low. In our current work, we are investigating unobtrusive sensing to discover when people experience high and low workload.

Recommendations on when to take breaks. We found that some participants took more physical breaks with online distractions blocked; others did not. Some users wanted to receive actionable insights from a system, such as suggesting a break schedule, recommending breaks when they have been working for long stretches of time. or recommendations for healthy breaks, such as taking a walk, stretching, or doing a yoga move. Research shows that walking breaks significantly increases attention and creativity [1]. With feedback, the system could adjust recommendations until it works for the user. Conversely, a few users wanted reminders to return to work, as well.

Setting time limits. Many participants felt a time limit on breaks is important. Our study adds to the literature showing that working long stretches is physically and mentally tiring [48]. Participants asked that software set limits for small "nuggets" of breaks, or microbreaks, e.g., 30 seconds to a few minutes, enough for a person to refresh or to "*scratch that initial itch*" of curiosity of checking a site. A sensing system that could sense workload from users' behaviors and emotional states could suggest breaks to refresh so that users could quickly reorient back to work.

Limitations

Our study had several limitations. First, it is possible that knowing that distractions would be blocked in the subsequent week could have affected behavior in the baseline week--this is true of any study where people expect to receive interventions. Also, it is not practical in real work organizations to cut off nonessential sites at all times. We had to balance the practicality of disrupting work routines, compliance, and participant payment. With a longer blocking duration, we would have a better picture of blocking effects, "survival rate" and whether more people may have been able to readjust their work patterns with new forms of breaks. However, we feel that one work week with reduced distractions was sufficient time to learn costs and benefits of such software, and individual differences. Future work could examine patterns of learning new online workplace skills for managing distractions over time. We stress that our study involved a small sample. Confirmatory studies are needed to verify that personality traits are associated with effects of distractions.

Though most sites that were blocked were social media sites, we cannot disentangle the effects of blocking social media from blocking all non-work related sites. Future work could focus solely on understanding how blocking social media affects work behavior.

We did not block phones with the software because it was not available for all phone types. Though participants complied moderately well, in a future study it is important to block phone use to test its distraction. Though we blocked personal email accounts, some personal email was read on work accounts so available email was not always strictly work-related. Also, our Cognitive Absorption measures were self-reports. Though it is a well-validated survey and used in technology studies, in the future we will log computer usage to provide more validation for the Focused Immersion variable. Last, our participants were college educated, working in a high-tech environment. Thus, our results can only generalize to such workers and environments.

CONCLUSIONS

Online distractions are a controversial aspect of our current technology-mediated workplaces. A number of commercial solutions, prototypes and workplace policies have been developed to address the perceived negative aspects of online distractions. However, whether these strategies help has not been well studied. Rather than ask people hypothetically to report experiences, our participants actually experienced how blocking distractions affected their work. For most, cutting off workplace distractions increases focus and productivity. Our study is a first step in suggesting that individual differences in managing distractions is important to consider in designing software to block distractions. People who benefited the most were those who felt less in control of computer work and most susceptible to social distractions. However, our results on the role of personality need to be verified with further research. As we construct workplaces of the future, we need to understand how technology support can help people better manage their distractions, so as to integrate them more beneficially into their work practices.

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