Bored Mondays and Focused Afternoons: The Rhythm of Attention and Online Activity in the Workplace

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ABSTRACT

While distractions using digital media have received attention in HCI, understanding engagement in workplace activities has been little explored. We logged digital activity and continually probed perspectives of 32 information workers for five days *in situ* to understand how attentional states change with context. We present a framework of how engagement and challenge in work relate to focus, boredom, and rote work. Overall, we find more focused attention than boredom in the workplace. Focus peaks mid-afternoon while boredom is highest in early afternoon. People are happiest doing rote work and most stressed doing focused work. On Mondays people are most bored but also most focused. Online activities are associated with different attentional states, showing different patterns at beginning and end of day, and before and after a mid-day break. Our study shows how rhythms of attentional states are associated with context and time, even in a dynamic workplace environment.

Author Keywords

Engagement; Attention; Multi-tasking; Focus; empirical study; workplace; computer logging; experience sampling

ACM Classification Keywords

H.5.3 [Information Interfaces and Presentation]: Group and Organization Interfaces; K.4.m [Computers and Society]: Miscellaneous.

INTRODUCTION

In recent years, a great deal of attention in the CHI community has been directed to understanding disruptions in the workplace, due to interruptions and task-switching, e.g. [4, 7, 10]. While it is important to investigate how a digital environment can introduce distractions, little research has been directed to the converse: understanding the nature of engagement in activity in the workplace. This is important because if we can gain insight into when people are engaged and involved in their work, this can inform the design of tools and interfaces to promote a better workplace experience.

The dynamic nature of the workplace can cause attentional states of information workers to change depending on many factors: the task-at-hand, interactions, their affective state, interruptions, and other contextual conditions, as well as online activities which constitute a large part of their work. Studies in the field of organizational and management science have investigated how people allocate their attention in the workplace, e.g. [26], but have mostly ignored online activity. However, given that information workers mostly engage in digital activities and tend to multitask frequently, digital work patterns can cause fragmented attention and changes in engagement in work. Under these premises, we feel that it is important to understand, broadly speaking, how people's attentional behaviors, and consequently, a notion of engagement, changes across activities and contexts in a real-world workplace environment. In the field of HCI, precision tracking methods are being developed to study *in situ* behavior including online activity, allowing us to gain a fairly precise "micro-view" into how human behavior and online activity are related (e.g. [15]).

In this current paper we report results from an *in situ* tracking study using online activity logging and experience sampling (i.e., probing the user throughout the day) that enabled us to discover how online activity is related to different attentional states. We first present a theoretical framework of four different attentional states derived from different combinations of engagement and challenge experienced while performing online activities. We then further characterize each state in terms of the online activities that people perform as they report experiencing that state. We utilize the attentional states to explain how people's behavior changes over the course of a day, and at periods contiguous to a break in activities. We discuss how the proposed attentional states can be used in real life settings to better understand and improve the workplace experience.

CHI 2014, April 26 - May 01 2014, Toronto, ON, Canada

http://dx.doi.org/10.1145/2556288.2557204

RELATED WORK: MULTITASKING AND ATTENTION

We first review studies related to attention and work in the HCI field, and then concepts closely related to engagement.

Multitasking and Disruption

A large body of 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. Czerwinski et al. [4] showed from a diary study how information workers switch activities due to interruptions in the workplace, focusing on the difficulty of the continuous switching of context. Iqbal and Horvitz [10] studied how external interruptions cause information workers to enter into a 'chain of distraction' where stages of preparation, diversion, resumption and recovery can describe the time away from an ongoing task. Gonzalez and Mark [7] reported on how information workers conceptualize and organize basic units of tasks and how switching occurs across these conceptual units. In the mobile domain, Karlson et al. [11] found that tasks on mobile phones become fragmented across devices and they identified challenges that exist in resuming these tasks.

While most studies have looked at distraction due to multitasking, no study to our knowledge in the HCI field has focused on the converse--how engagement and challenge are associated with a person's current type of activity. Such characterizations can provide insight into when a person is focused and consequently more productive as well as providing an understanding of when downtime occurs and what types of activities entail lack of focus.

Engagement in the workplace

Other theoretical constructs exist that can be related to engagement in activity. *Cognitive absorption* refers to when people experience total immersion in an activity, characterized by deep enjoyment, a feeling of control, curiosity, and not realizing the passing of time. Cognitive absorption has been shown to be associated with ease of use and perceived usefulness of IT [1]. *Cognitive engagement* is similar to absorption, involving curiosity, deep interest and attentional focus, but without a feeling of control of the situation [25].

Mindfulness refers to a psychological state focused on phenomena (both externally and internally) with the emphasis that attention is geared to the present moment [5]. Weick characterizes mindfulness in organizational work as being aware of fine detail, affording the capacity to discover and manage unexpected events [26].

Flow refers to a state of total immersion in an activity, where according to Csikszentmihalyi [3]: "*Nothing else seems to matter*." High challenge and high use of one's skills are preconditions for the flow state; however, their presence do not guarantee that the flow state will occur. Tasks that are not challenging rarely are associated with flow, whereas tasks that present challenges, utilizing one's skills, and that require attention, can be associated with the flow experience [16]. Time spent with engaging and challenging activities is positively correlated with a high quality of experience [12].

Flow, absorption, and cognitive engagement have been found to be associated with high positive affect [1, 3, 25], while states of boredom are associated with negative affect [16]. On the other hand, Schallberger [19] found that challenge in work could involve both high positive and negative affect. The underlying dimension is activation which could relate to either type of affect. Testing this idea, Gross et al., [8] found that positive events in the workplace result in resource replenishment, especially under conditions of chronic stress or duress. They argue that positive events could either replenish or deplete cognitive resources.

The concepts of flow, engagement and absorption are relevant to our work as they refer to active states of attention, e.g., as Weick and Sutcliffe [26] describe: "*the capacity to take action.*" More specifically, they are associated with times when people are highly engrossed in their activity. However, we are also interested in states of attention when engagement in work may not be high.

ACTIVITY ENGAGEMENT AND CHALLENGE IN WORK

We are interested in gaining a perspective on the counter phenomenon to distractedness due to digital media (e.g. [4, 7, 10]): what is associated with people's engagement in their digital activity at work? For example, if we consider email usage, on the average, are people engaged and challenged in managing their email or is this more of a mechanical task? Are there certain times of the day when people have more of a focused effort in their work and other times when they tend to be less engaged? Are people happier when they are focused in online activity or rather when the work they are doing is more of a rote task?

We first began conceptualizing this problem by measuring engagement in activity. However, measuring engagement does not reveal a full picture about how one relates to an activity. One can be engaged in work that is quite effortless, such as copying figures, or filling out forms. On the other hand, one might be engaged in a task that is more consuming, presenting a challenge to their skills, i.e., that involves a mental effort such as writing an article. It is important to consider both engagement and challenge together, as these have been associated with creativity in work [12].

Therefore, to measure engagement in work where people are also expending mental effort, we also consider how much of a challenge that activity presents to the user. We define challenge as the amount of mental effort that one must exert to perform an activity. We therefore measured two dimensions that we feel are highly relevant in capturing task involvement the workplace: the degree to which one is engaged in the activity, and the degree to which one is challenged in the activity. The choice of these dimensions is

informed by those used commonly in studies measuring quality of experience, for example, in relation to work and leisure (for a review see [9]).

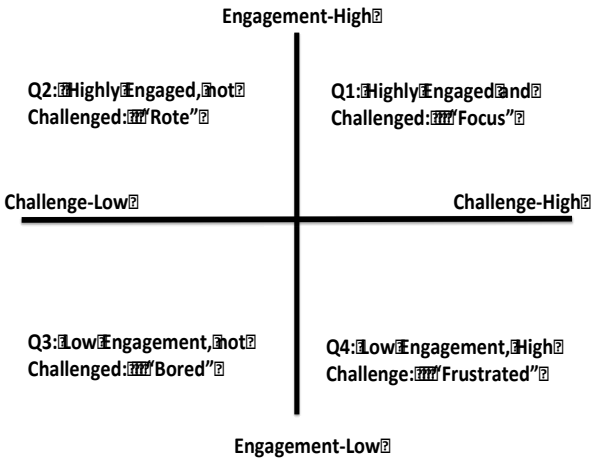

Figure 1. A theoretical framework of quadrants representing different attentional states in the workplace.

Engagement in work has been studied extensively. We follow the definition of Schaufelli et al. [20], who define engagement as a state of mind where one feels absorbed and dedicated in work. For a review on how engagement has been characterized and studied with work, see [13]. Importantly, users' self-ratings of engagement, found to have situational validity, have been used in numerous experience sampling studies--see [9] for a review.

Challenge has also been studied thoroughly in the workplace and has been validated as a construct in experience-sampling studies as part of the experience of "flow." See [9] for a review of different contexts in which challenge has been measured.

Focus, Boredom, and Rote work: A theoretical framework

To visually conceptualize different types of task involvement that people might experience in the workplace at different times in terms of engagement and challenge, we present a theoretical framework, as shown in Figure 1. We expect that people fluctuate across these attentional state boundaries throughout the day, depending on the task, interactions, and other contextual factors.

The upper right quadrant (**Q1**) indicates that at times people may be highly engaged in an activity and also challenged. This quadrant represents a temporal state when people feel absorbed in an activity, i.e., are "active" in their focus of attention because the activity requires some amount of mental effort. In English slang terms, perhaps the best characterization is that people are "into" their work. We are interested in examining those times during the workday when people experience activities of this nature. We apply the label of "Focus" for this quadrant to refer to a state where people are actively focused and feel that the activity affords some degree of challenge to their particular skill set.

The upper left quadrant (**Q2**) refers to times when people feel engaged but not challenged. This state can characterize an activity that requires attention but requires little mental effort to accomplish. An example might be transcribing numbers or playing an online game such as solitaire. We label this quadrant "Rote" to refer to a state where people are engaged, but the work is not challenging. Rote work is defined as "*mechanical or unthinking routine or repetition*" (Merriam-Webster).

The lower left quadrant (**Q3**) depicts those times during the workday when one feels neither engaged nor challenged in their work. These feelings could be consistent with a feeling of boredom and we label this quadrant "Bored". The lower right quadrant (**Q4**) describes a state where one feels challenged but is not engaged in work. An example of such activity is when a software developer feels that a bug is very difficult to solve and has little to no interest in working on it. We label this quadrant "Frustrated."

We emphasize that our labels are merely used as referents and may not fully characterize the definitions precisely. It is worth mentioning that this set of dimensions is related to the dimensions used to measure the *preconditions* for the experience of flow [9]. People who experience flow describe the experience as one involving high concentration, engagement, absorption, and challenge in the activity. It is important to note that our framework does not specifically identify a flow experience. Rather we are simply using the concept of flow as an example of the type of experience that people *could* experience if people's self-reports occur in the upper right quadrant. While the Focus quadrant in our framework is most relevant to flow, it captures a subset of characteristics specific to flow, namely engagement and challenge. We feel that it is important to understand when people are experiencing a "Focus" in work activity because it has been shown that being highly engaged and challenged in work is correlated with motivation, activation, concentration, creativity, and satisfaction [12].

RESEARCH QUESTIONS

How do people's engagement and feeling of challenge correspond with their task activity? The workplace is dynamic and we expect that information workers can change their psychological states of attention depending on a host of factors: their task-at-hand, interactions, their affective state, interruptions, and other contextual conditions. Our goal is to understand how a feeling of being involved in work is related to the use of digital technology. We have broken this broad question down into several research questions.

RQ1. How is affect, in terms of valence, associated with different attentional states? Are people happiest when their attention is focused in the workplace? Valence [18] refers

to the range of positive to negative emotions one might feel (usually together with the dimensions of arousal) and has been widely used to study affective state [21]. We will investigate the relationship of the different attentional states in our framework using valence. In particular, we will examine whether focused effort in work is associated with positive affect as flow, engagement and absorption studies suggest [1, 3, 25], or rather, because it also encompasses challenge [19], is it associated with negative affect? Also, as Tschan et al. [24] have shown that one's organizational work role is related to the emotional quality of life, we will examine the influence of work role as well.

RQ2. How do people's attentional states change over the course of the day? Can we find temporal patterns that correspond to focus and boredom in individuals? Some work has suggested that people may have different "rhythms" of work. Begole and Tang [2] looked at people's email usage and showed that people tend to exhibit fairly regular rhythms for some digital activity. With this research question we examine whether we can detect discernible temporal patterns of behavior of focused attention and boredom concurrent with other media usage.

RQ3. How are different attentional states related to online activities? Related to RQ2, we examine how different types of digital activity relate to measures of engagement and challenge, i.e., to the quadrants as shown in Fig. 1. It is an open question to what extent people feel engaged and challenged when they conduct activities such as reading email or using Facebook in the workplace.

RQ4. How do people's attentional states change over the course of the week? Might people's attentional states vary depending on the day of the week? Does the so-called Blue Monday effect, where people are in a bad mood on Mondays [22], affect the ability to focus, or after a weekend break might people be more focused? Does focused behavior wax or wane over the week? Here we compare attentional states to online behaviors over the week.

RQ5. Does a break in work replenish attentional resources? This question addresses two times of the workday: *(a) Are people more (or less) focused at the beginning or end of day? (b) Are people more (or less) focused before or after lunch, which represents a mid-day break?* There is some reason to believe that people might be more focused when starting work at the beginning of the day or after a break. A study of rulings of Israeli judges found that more favorable rulings were given at the beginning of the day, and after a lunch break. [6]. One explanation for this result could be that breaks can lead to higher positive affect (possibly accompanied by lower mental workload) which in turn can restore people's mental resources when depleted [23].

METHODOLOGY

We conducted an *in situ* study in the fall of 2012 at a large U.S. corporation. We used a mixed-methods approach where we combined automatic data collection of digital activity with experience sampling. The automated data collection allowed us to track a wide range of digital activities with detailed precision. Experience sampling was used to collect user perceptions of engagement and challenge, as well as other self-report measures at intervals throughout the day. We also deployed surveys for other subjective and demographic measures. Further details of these, and other, measures not reported in this paper can be found in [14] .

Participants were recruited through advertising, convenience sampling and recommendations of participants. Thirty-two people (17 females, 15 males) participated. Participants included researchers (15), managers, administrators, an engineer, a department director, a designer, and a consultant.

Methodology. Each participant was observed for a period of five days, Monday through Friday, for most people. When participants traveled or missed a day, they made up the missed day the following week (in most cases). The computer logging software and experience sampling software were installed on participants' computers the Friday before the study began. Participants were assured of anonymity in their data.

We logged online interactions with custom-built software that captured all activity in the Windows 7.0 Operating System. This included beginning and end times for the lifespan of every window, and the beginning and end times for every instance of every foreground window. Mouse and keyboard activity were captured, as was computer sleep mode, so that we could ignore periods of time when a window was open but was not being used in the foreground. Capturing what email was being read or any other application interaction was not collected due to privacy and technical limitations.

We used *experience sampling,* in the form of a small pop-up window that appeared on the computer screen to capture the participants' perspective *in situ*, i.e., as the situated nature of the environment changes. Experience sampling has been shown to have internal validity as well as external validity [9]. Experience sampling has been used extensively in studies to capture the flow experience [9]. We used a hybrid interval-contingent and event-contingent sampling approach [9]. The sampling was done: 1) whenever a user left email after uninterrupted active use in that application for at least three consecutive minutes or when in Facebook after a full minute, and 2) whenever a user logged into Windows or unlocked the screen saver (event-contingent). If 15 minutes passed without a sampling, then a probe was triggered (interval-contingent).

Participants were instructed to go about their usual workday activities and were told to answer the experience sampling probes when the probe windows popped up on their computer screens. We emphasized that they should answer

the probe questions as accurately as possible but they could cancel the probe window at any time. Subjects were given the following verbal and written instructions:

"Sometimes the rating scale will pop up and may annoy you, especially if you were in the middle of doing something. If you feel annoyed, do not rate your mood based on the annoyance of the pop-up window. Instead, rate your experience based on the task or interaction you were doing at the time of the pop-up window. If you feel that you cannot rate your mood fairly due to the annoyance of the pop-up window, then hit 'cancel' and the window will disappear."

We used rating scales used in other experience sampling approaches [21] to measure the following: for Engagement, participants were asked 'In the task/interaction you were just doing: How Engaged Were You?' using a 6-point Likert scale (0=Not at All; 5=Extremely). To measure Challenge, participants were asked the same question as above, but instead: "How Challenged Were You?' using the same Likert scale: (0=Not at All; 5=Extremely). We also measured Valence (positive and negative affect) and Arousal using the question "Please rate how you feel right now", based on Russell's 2-dimensional Circumplex model [18]. Valence was measured on a horizontal scale which corresponded to a range of -200 (negative affect) to +200 (positive affect). Arousal was measured on a vertical axis that crossed the Valence axis using a range of -200 (low arousal) to +200 (high arousal). Subjects were asked to click with their cursor on that point in the 2x2 grid that best expressed their feeling "right now." The timestamp when participants submitted the probe was recorded. Valence measures have been reported to have high internal consistency [9]. For a review of the Circumplex measure for Valence/Arousal, including its validity, see [17].

RESULTS

We collected data on each of the 32 participants for 5 days each, for a total of 160 person-days, or 1,509 hours of data collection. Our computer logging software collected 91,409 computer window switches. We collected 2,809 experience sampling probes. Each person averaged 17.56 probe responses per day, for an average of 87.8 probe responses per participant over the five study days.

Experience sampling studies of flow have mostly used normalized scores in analyses [16]. We thus normalized all responses. We chose to exclude the mid-range values and just use the top and bottom thirds of the normalized responses as our intent was to investigate those aspects of the participant experience which we felt better corresponded to our framework in Figure 1. Mid-scale ratings are more ambiguous in their interpretation. We thus combined the top third of the normalized Engagement ratings and top third of the normalized Challenge ratings to create the category of "Focus" (Q1, see Fig. 1). The top third of normalized Engagement ratings and bottom third of normalized Challenge ratings were combined for the category of "Rote" (Q2). The bottom third of normalized Engagement ratings and bottom third of normalized Challenge ratings were combined for the category of "Bored" (Q3) and the bottom third of normalized Engagement and top third of normalized Challenge ratings were combined to yield the category of "Frustrated" (Q4). As only seven responses occurred in Q4 ("Frustrated"), we disregarded this category for the rest of our reported analyses. Of all the probe responses, 42.9% occurred in one of the four quadrants in Fig. 1. All participants gave ratings in two or more quadrants; only five participants did not have a rating in all three quadrants during the study period. Participants' end-of-day ratings on their feeling of productivity for the day showed no significant association with any of the four quadrants.

RQ1. Valence and activity involvement

Our first research question asked how attentional state is associated with positive affect, represented by the Valence measure. We compared Valence self-reports between the three quadrants. We used a linear mixed model (LMM), with Subjects as random effects, to handle the correlated data. There was a significant difference of Valence levels among quadrants: $F(2, 1134)= 53.17$, $p<.0001$. A Bonferroni test set at .05 showed a significant difference among all means. Contrary to our expectation, participants had the highest positive affect when they were doing "Rote" work: being highly engaged but not very challenged, and were the least happy when bored (Q3). Mean Valence (non-normalized) ratings (on a scale of -200 to +200) are: Focus=34.49, SE=7.15, Rote=77.36, SE= 7.76 Bored=18.82, SE=7.22.

Prior work in flow suggests that being in a state of flow causes people to be happy [3]; however, our results did not find this to be the case for Focus, the state in our framework closest to flow. To investigate this further, we reasoned that focused activities may occasionally cause stress, which may be responsible for why people are not happiest when reporting they are focused (Q1). Depending on the situation, stress can influence affect [21].

To further understand the relationship between affect and the attentional states in our framework, and stress in particular, we looked deeper into the mood ratings of Valence and Arousal collected through the self-reports. Stress is defined as high arousal and low valence [17] and has been well validated with experience sampling [18]. We normalized the Valence and Arousal ratings. We divided up our valence and arousal measures into four categories, generically labeled: "**Happy**" (Valence >0 and Arousal >0); "**Stressed**" (Valence < 0 and Arousal > 0); "**Calm**" (Valence > 0, Arousal < 0) and "**Bad Mood**" (Valence < 0, Arousal < 0). Note that self-reports of '0' are not included in the mood ratings. Again, we use these terms simply as referents for readability; mood states associated with the circumplex model are more nuanced [18].

Table 1 shows the counts of all participants' self-reports of Mood Types x Attentional states. To handle the correlated

	Mood Type				
	Bad mood	**Stress**	**Calm**	**Happy**	**Total**
Bored	194 (47.8%) (67.8%)	55 (13.5%) (22.6%)	110 (27.1%) (60.4%)	47 (11.6%) (11.0%)	406 (100%)
Rote	21 9.7% (7.3%)	39 (18.1%) (16.0%)	27 (12.5%) (14.8%)	129 (59.7%) (30.1%)	216 (100%)
Focus	71 (13.7%) (24.8%)	149 (28.8%) (61.3%)	45 (8.7%) (24.7%)	253 (48.8%) (59.0%)	518 (100%)
Total	286	243	182	429	1140

Table 1. Counts of self-reports: Mood Type over the different quadrants. Row percentages are above column percentages in parentheses.

data within participants, we conducted a generalized linear mixed model analysis (**GLMM**) in SPSS which can be used for categorical dependent variables. We found a significant relationship between Mood Type and Quadrant: $F(6, 1132)=45.76$, $p<.0001$. In Q1 (Focus), most people self-reported as happy. Yet when people do rote work (Q2), they also mostly report being happy. When people are bored (Q3), they also mostly report being in a bad mood. Of all stress self-reports, most occurred in Focus (61.3%), whereas only 16.0% occurred in Rote and 22.6% in Bored.

Therefore, because a higher percentage of stress reports occurred in Focus, this could be an explanation for why people did not report having the most positive affect in this state. When people are consumed by an activity, it can be either gratifying or stressful, depending on the context [24].

As degree of work involvement could be tied to gender or one's work role [24], we examined these factors. In the survey, participants identified their work roles and these were coded into three categories: concerning Administration and technical support (5 people), Research (19), and Management (8). A multivariate GLM test showed no significant difference for Gender or Work Role with attentional state.

RQ2. Focus at 3 p.m.: Time of day and activity involvement

In this research question we reasoned that Focus and Boredom reports range over the time of day in relation to other digital activity (and other contextual factors which could be related to time). Fig. 2 shows how self-reports in the Bored and Focus quadrants change over the course of the day, averaged over all days and all subjects. The time span is 7 a.m. to 9 p.m.

Overall, participants report being more focused than bored in the workplace. People are most focused in their work mid-afternoon, with a peak at 2-3 p.m. when the use of productivity apps (e.g., Word, Excel, Visual studio), Email, and viewing the Inbox/Calendar app are at their highest usage. Focus is also high at 11 a.m., which is generally

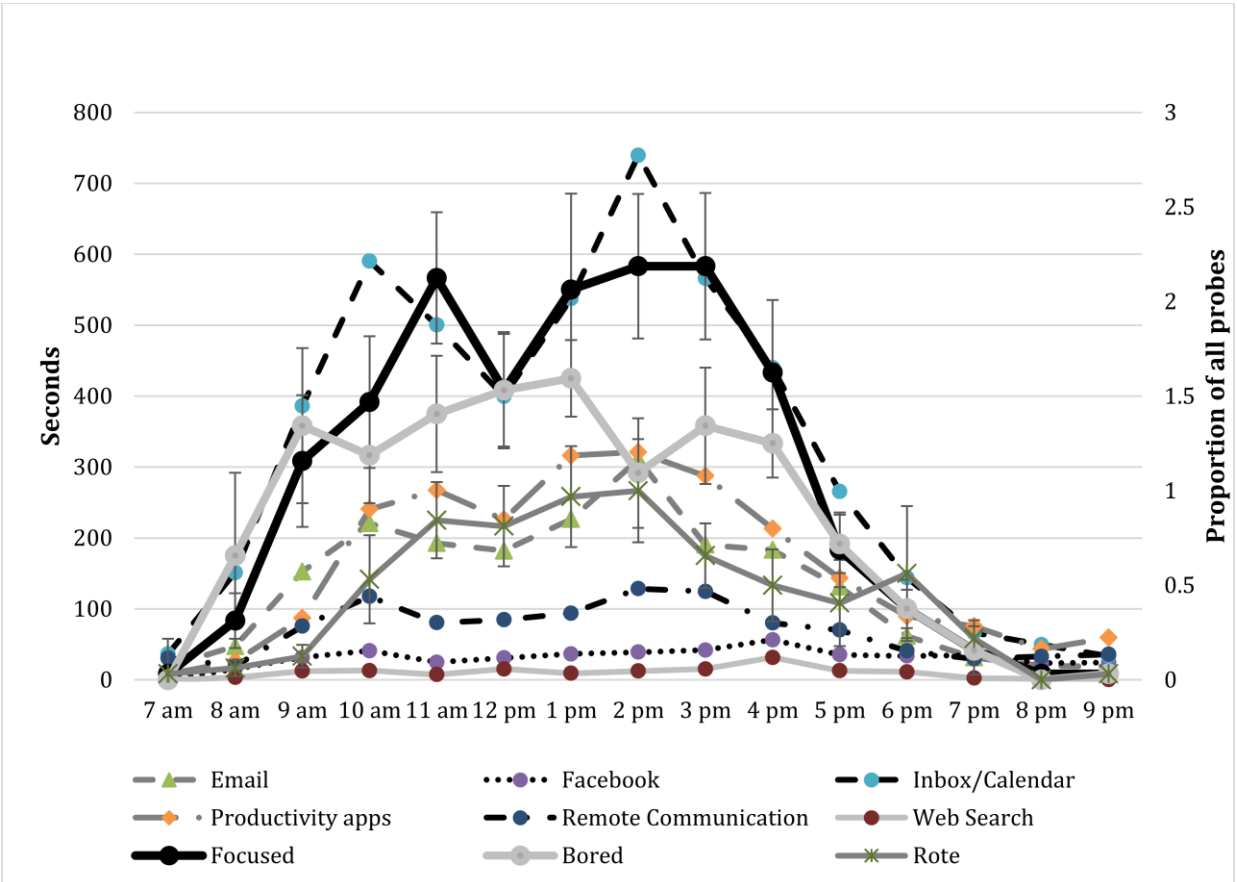

Figure 2. Focus, Rote and Boredom ratings over the course of the day, in relation to other digital activity, averaged over 32 subjects, 5 days. Error bars for Focus, Rote and Bored show SE of the mean.

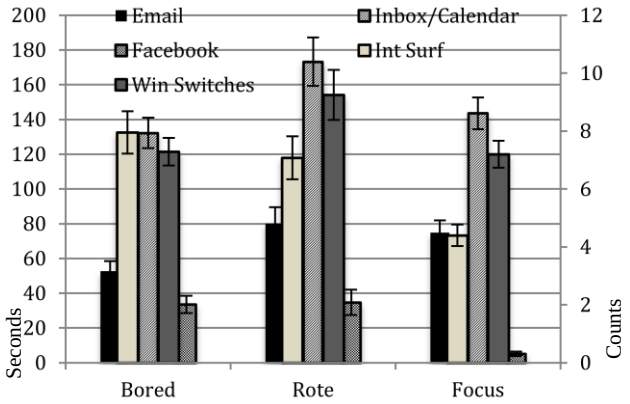

Figure 3. Means of online activity (sec. and counts 10 min. prior to probes) for the quadrants. Error bars show SE.

before a break for lunch, when the reports then dip. After peaking mid-afternoon, Focus reports continue to decline until when most people typically leave work. The majority of participants report being most Bored at the beginning of the day (9 a.m.), and Bored reports peak at 1 p.m. Boredom is at the lowest at 2 p.m. Remote communication (e.g., Skype, Instant messaging) is highest at 10 a.m. and between 2 and 3 p.m. The use of FB, non-work email (i.e., web email), and information seeking (i.e., web search) is done continually throughout the day in a fairly uniform manner.

RQ3. The not-so-boring work of email: Digital activity and focus

While fig. 2 shows the data averaged over all participants, in this research question we take individual differences into account, investigating how different types of online activity relate to the amount of engagement and challenge experienced. We compared computer activity that occurred in a window of time 10 minutes prior to each probe, for the most frequently used applications selected from fig. 2 (duration measured in seconds): Email reading/writing (**Email**), Facebook (**FB**), Email inbox and Calendar viewing[1] (**Inbox/Cal**), and counts of: switches on the Internet (i.e., **Internet surfing**), and computer window switches (**Win Switches**) were analyzed. Means are shown in Figure 3.

Using a linear mixed model (**LMM**) with Subjects as random effects, significant differences were found among quadrants in Figure 1 with Email: $F(2,1122)=4.59$, $p<.01$. A Bonferroni comparison set at .05 showed that users spent significantly less time on Email while reporting Bored compared to Focused (see Fig. 3). There were also significant differences with FB ($F(2, 1055)=12.08$, $p<.0001$), and a Bonferroni test at .05 showed that users spent significantly less time on FB in the Focus state, compared to both the Bored and the Rote states. Internet surfing showed a difference among quadrants: $F(2, 1134)=6.46$, $p<.002$, and a Bonferroni test (.05) showed that participants spent more time Internet Surfing while in the Bored state compared to the Focused state. Using a log transform of the amount of Win Switches due to lack of normality, differences were also found: $F(2, 1115)=5.19$, $p<.006$, and a Bonferroni test (.05) showed more Win Switches in the Bored state compared to the Focused state. A log transform of the amount of Inbox/Calendar use showed a trend for a difference: $F(2, 1127)=2.78$, $p<.06$. A Bonferroni test showed a trend ($p<.06$) that more Inbox/Calendar use occurred in the Bored than Focus state.

[1] Note that Email refers to reading and writing email; Inbox/Cal refers to only when the Email Inbox is in the active window.

	M	T	W	Th	F	Total
Bored	113 (27.8) (39.9)	104 (25.6) (46.2)	76 (18.7) (33.5)	59 (14.5) (26.6)	54 (13.3) (29.5)	406 (100%)
Rote	46 (21.3) (16.3)	37 (17.1) (16.4)	43 (19.9) (18.9)	64 (29.6) (28.8)	26 (12.0) (14.2)	216 (100%)
Focus	124 (23.9) (43.8)	84 (16.2) (37.3)	108 (20.8) (47.6)	99 (19.1) (44.6)	103 (19.9) (56.3)	518 (100%)
Total	283	225	227	222	183	1140

Table 2. Counts of activity reports by day of week. Row percentages are above column percentages in parentheses

Therefore, we found that attentional states vary with types of digital activity. With email, on the average, people report least being in a Bored state. In contrast, switching windows, surfing the Internet, and using the Inbox/Calendar are associated with a Bored state. When people use FB, they generally do not report being in a Focused state.

RQ4. Bored Mondays: Days of week and activity involvement

Feelings of boredom and focus may vary depending on the day of the week. Table 2 shows a breakdown of self-report counts in each quadrant, by day of the week. A GLMM (to handle the correlations within participants) shows a significant relationship of Day of Week with attentional state: $F(8, 1130)=4.86$, $p<.0001$. Participants report most in the Focus quadrant on Mondays but also they report most being Bored on Mondays. People do most rote work on Thursdays. A Bonferroni test set at .05 showed reports on Monday and Tuesday are significantly different than reports on Wednesday, Thursday, and Friday.

To investigate further whether attentional states might be tied to specific online activity, we compared the means of different types of computer usage over Day of the Week: Email, Facebook, Inbox/Cal, Internet Surfing and Win Switches. Using a LMM, we found that only Win Switches showed a significant difference ($F(4, 157)=3.03$, $p<.02$) and Internet surfing showed a trend ($F(4, 157)=2.21$, $p<.07$), over Day of Week. A Bonferroni test (.05) showed Win Switches were significantly higher on Monday ($M=661.2$ switches/day, $SE=69.60$) than Friday ($M=390.7$ Win switches/day, $SE=28.7$), and also that Internet surfing is

	First hour	Last hour	t	p
Email[1] (sec.)	332.85 (38.91)	251.38 (35.53)	2.22	.03*
Web Email (sec.)	39.26 (11.27)	29.23 (7.89)	.84	.40
Facebook (sec.)	56.78 (13.51)	75.29 (21.95)	-.75	.46
Inbox/Cal (sec.)	870.72 (63.52)	608.78 (58.92)	3.58	.0001*
Internet Surfing (counts)	36.33 (44.33)	33.49 (45.35)	.84	.40
Win Switches (counts)	91.60 (6.42)	79.23 (6.21)	2.06	.04*
Productivity Apps (sec.)	252.72 (517.35)	411.36 (825.25)	-2.28	.02

Table 3. Means (SE) in seconds of online activity in the first and last hour of the day. *=p<.05.

higher on Monday (M=280.8 switches/day, SE=42.9) than Friday (M=151.3 switches/day, SE=16.2). Interestingly, Table 2 shows about double the incidence of reports in the Bored quadrant on Monday (27.8%) compared to Friday (13.3%), along with higher window switching and Internet surfing. Thus, we find a relationship with online activity and Mondays, the day when people report being the most bored, but at the same time also the most focused.

RQ5a. Activity involvement: beginning and end of day

Are people more focused or bored at the beginning or end of the day? We contrasted self-reports at the beginning and end of the day along with the change in online activity. For beginning and end times of day, we used the first and last hour of each participant's data. To correct for a lack of normality in the distributions, we did log transforms of Email and Win Switches. We also analyzed Web email as this is non-work email and could be related to boredom.

A related-samples Wilcoxon-signed rank test showed no difference in proportion of self-reports in the Focused or Rote quadrants in the first and last hour of the day. A slight trend shows that participants reported being more Bored at the beginning rather than at the end of the day, p=.10. A paired t-test showed no significant difference in Valence or Arousal.

A paired t-test of First and Last Hour (Table 3) shows that significantly more time is invested in managing corporate email in the first, compared to the last, hour. We also find that more time is spent with the Inbox/Cal as an active window in the first, compared to the last, hour. Our participants switched windows significantly more in the first hour, compared to the last hour. Productivity App usage shows the contrary: significantly more time is spent in the last, compared to the first hour of the day.

	Before Mid-day break	After Mid-day break	t	p
Corporate Email (sec.)	321.53 (49.24)	276.63 (50.85)	.64	.52
Web Email (sec.)	43.50 (18.43)	101.63 (35.89)	-2.28	.03*
Facebook (sec.)	47.10 (12.30)	104.38 (32.76)	-2.00	.05*
Inbox/Cal (sec.)	843.00 (91.76)	712.44 (79.38)	1.13	.26
Internet Surfing (counts)	39.13 (6.57)	41.57 (8.28)	-.28	.78
Win Switches (counts)	89.72 (9.74)	97.81 (11.68)	-.62	.54
Productivity Apps (sec.)	285.14 (70.12)	442.74 (87.31)	-1.66	.10

Table 4. Means (SE) in seconds of online activity in the hour before and after a mid-day break. *=p<.05.

Q5b. Activity involvement: before and after a mid-day break

We examined self-reports in the hour before and after a mid-day break (i.e., lunch). Mid-day break was defined as: 1) a break of 20 minutes or longer in computer activity) between the hours of 11 a.m. and 2 p.m. (which is when the company cafeteria was open), and 2) if participants responded in the first probe after the break that they had had a scheduled face-to-face meeting, then this break was excluded from analysis. As not all people who took a break may have eaten lunch, we label this as a "mid-day" break.

A related-samples Wilcoxon-signed rank test showed no difference in proportion of self-reports in any of the quadrants before and after the mid-day break (Table 4). A paired t-test showed no difference in Valence or Arousal.

A paired t-test revealed that only Web email and Facebook showed significant differences before and after a mid-day break. In both cases, the usage increased after the break. A weak trend showed that productivity apps increased as well.

DISCUSSION AND CONCLUSIONS

While a large body of research in multitasking has focused on distractions, our research examines the alternative view--various levels of activity engagement in the workplace, in particular, an attentional state of 'Focus.' Our study provides three main contributions: a theoretical framework to explain different attentional states in the workplace; a novel methodology combining computer activity logging with the user's perceptions; and empirical results showing how different attentional states are associated with contextual factors in the workplace: valence and mood, online activity, time of day, time during the week, and the role of breaks.

In sum, our results show that overall, our participants had more focused attention than boredom in the workplace.

Focus peaks mid-afternoon while boredom peaks earlier in the afternoon. Unexpectedly, we found that people are happiest doing rote work; we explain this by showing that focused work can involve stress. We also found that people's attentional states shift as their online activities change, e.g., email can be rote or focused work while Facebook does not require focused attention. We also found that day of the week is associated with attentional state: Mondays appear to be people's most bored day. Our result contributes to the debate on whether a "Blue Monday" effect exists, cf [22]: perhaps on Mondays people are not "blue" but rather bored.

Previous studies of tracking workplace behavior with ethnographic and automated methods (e.g. [7, 15]) did not capture the user perspective. For example, it could not be known how engaged a user was with a window in active use. With our experience sampling method we were able to periodically gain insight into what the user was experiencing at the time that the computer windows were actively being used. This enabled us to understand on the average how people experience online activity, e.g., that when people switch windows they are bored. We hope that these results can lead to further research.

While being in a state of flow (high challenge and high skill, associated with high engagement) is thought to result in increased happiness and satisfaction [3], the corresponding state of Focus in our framework does not yield the most happiness. In fact, our participants were happiest when doing rote work. Our result of Focus self-reports is consistent with findings of Schallberger [19], who found that high challenging activities at work are associated with *both* negative and positive "activation", which refers to both high positive energy and high stressful feelings. Similarly, our results are loosely related to findings by Tschal et al. [24], who cite evidence supporting both replenishing and depleting effects of positive events in the workplace. Our results are counter to those found in flow and absorption studies which generally find highly positive experiences [1, 3] which suggests that our Focus state is distinct from a state of flow or absorption. We found that activities that demand high engagement and high challenge can in fact also involve stress, as well as happiness.

Our framework can be used by others to assess engagement and challenge in work activities. Our results are based on repeated responses of participants over a period of five days, roughly 40 hours. Though Engagement and Challenge have been validated as separate dimensions capturing experience, as a first step our results suggest "situational validity", or the internal logic [9] of the framework. The probes occurred in a variety of contexts and times yet on the whole seemed to capture what is intuitive.

Our study shows how different attentional states vary in the workplace according to context: type of online activity, time of day, and even day of the week. We had expected to find higher focus reports at the start of the workday and after a mid-day break, but various contextual factors and individual differences could explain this. A future study could target analyzing attentional states at key times to test whether breaks can replenish attentional resources [23].

Our work extends the multitasking literature which has so far been agnostic about attention *before* a distraction. It is possible that if people are doing boring or rote work, they might be more easily distracted, and thus susceptible to interruptions. Our FB result (RQ3) is consistent with this idea: people are not focused when they use FB. Similarly, Internet surfing and window switching are both associated with the Bored state, activities we think of as interruptions. Thus, our work raises the question: it may not be the interruptions that break focus; it may be that lack of focus comes *first*, leading to susceptibility to interruptions.

The results of this study suggest that people may gradually move into a Focused state (see Figure 3). Activities that are more personal and less critical, e.g., Facebook and personal email, may allow people to slowly ease into a more engaging and productive state when they more heavily use Productivity Applications, as we found.

How can these results be used in practice? We provide a methodology for assessing people's attentional states as focused, bored, or doing rote work, which can be applied in a range of studies, for example in examining the effects of tool adoption or organizational interventions. Our results provide basic and valuable information about workplace behavior that can lead to further studies on how to promote focus. Further, our results can help address a long-standing question in the domain of interruption and multitasking: when are opportune moments to interrupt? We would propose *not* interrupting users when they are in the focus state unless the topic of interruption is of high priority or is highly related to the work in focus. Finally, we believe that our results can be used to inform the design of workplace tools so they can promote more focus during use.

Limitations

Our participants were highly educated information workers (all had at least a Bachelor's degree). We must be cautious in generalizing our results to a broader sample. However, our sample of 32 participants is more than double that of other work observation studies, e.g., [4, 7]. We feel that data collected for five full days per person enabled us to analyze the variability of attentional states across a range of contexts. Also, the experience sampling methodology can interrupt participants. We did carefully instruct participants not to reflect their annoyance of the probe in their rating.

We realize that our attentional state labels may not reflect the true construct of what we were measuring. Quite literally, participants were rating how engaged and challenged they felt at that moment. It is therefore more accurate to consider the quadrants in our framework in terms of these dimensions than the referent labels we used.

Studying focused attention in the workplace provides a counterpoint to the study of digital media distractions. We hope that our study can lead to comprehensive approaches to studying digital media use and effects in the workplace.

ACKNOWLEDGMENTS

This material is based upon work supported by the NSF under grant #1218705. We thank Duncan Brumby and Alfred Kobsa for their valuable comments.

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