

Capturing the Mood: Facebook and Face-to-Face Encounters in the Workplace

Gloria Mark¹, Shamsi Iqbal², Mary Czerwinski², Paul Johns²

¹Department of Informatics
University of California, Irvine
Irvine, CA 92697 USA
gmark@uci.edu

²Microsoft Research
One Microsoft Way
Redmond, WA 98052 USA
{shamsi,marycz,Paul.Johns}@microsoft.com

ABSTRACT

What makes people feel happy, engaged and challenged at work? We conducted an *in situ* study of Facebook and face-to-face interactions examining how they influence people's mood in the workplace. Thirty-two participants in an organization were each observed for five days in their natural work environment using automated data capture and experience sampling. Our results show that online and offline social interactions are associated with different moods, suggesting that they serve different purposes at work. Face-to-face interactions are associated with a positive mood throughout the day whereas Facebook use and engagement in work contribute to a positive feeling at the end of the day. Email use is associated with negative affect and along with multitasking, is associated with a feeling of engagement and challenge throughout the day. Our findings provide initial evidence of how online and offline interactions affect workplace mood, and could inform practices to improve employee morale.

Author Keywords

Mood; affect; Facebook; face-to-face interaction; multitasking; email

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

Mood in the workplace has long been a subject of interest in fields ranging from organizational science to psychology. In the field of CSCW, although some attention has been given to how interactions in general influence mood (e.g.,

[44]), and how affect is conveyed through computer-mediated interaction (e.g., [20]) and social media [4], little attention has been given to how workplace interactions affect mood. This is important, as mood has been shown to impact performance in the workplace [3].

Understanding how such interaction affects mood in the workplace is important for organizations as both online and offline interactions continue to be integral parts of the daily routine of workers. Social networking sites (as well as other social media) are being deployed increasingly more in organizations and they amplify opportunities for online interactions.

In a work environment, it is an open question how face-to-face and online interactions compare in affecting mood. To our knowledge, this has never been investigated before. On the one hand, we might expect online interactions to positively affect mood, as has been found with face-to-face interaction in field experiments [43, 44]. On the other hand, interactions could be associated with work interruptions and task demands which have been shown to increase stress [37, 38], which in turn could negatively impact mood. In this paper we investigate how face-to-face and online social network interactions influence mood in the workplace. These interactions typically occur in an environment where task switching and interruptions are prevalent [10, 17]; we also investigate how this multitasking context affects mood.

To gain a deeper understanding of how online and offline social interactions affect people's mood at work, we conducted an *in situ* study at a large U.S. corporation. Our focus was to examine the influence of both face-to-face interaction and Facebook use on a breadth of workplace affective states. We chose Facebook because of its reported versatility and fairly high adoption in the workplace [50]. This research is part of a larger project: WorkSense, which has the goal of understanding people's workplace behavior via automated data capture and other methods. We found that online and offline social interactions are associated with different mood experiences suggesting that they serve different purposes at work. Face-to-face interactions are associated with people being happy throughout the day whereas Facebook use and being engaged in work

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contribute to an overall positive feeling at the end of the day. Our results showing the effects of online and offline social interactions on mood may have implications for workplace practices to improve employee morale.

EFFECTS OF SOCIAL MEDIA USAGE ON MOOD

Pew reports show that in 2012, 67% of internet users said that they used at least one social network site (SNS) [14]. This is over double the percentage from a similar study in 2008 (as reported in Hampton et al, [18]). Over half of these SNS users (71%) were female, and while the largest demographic continues to be 18-29 years of age, 52% of 50-64 year olds were using SNS sites and 32% were over 65. Of these sites, Facebook has been the dominant site used, with 92% of SNS users reporting they were on Facebook. The Pew report also documents that between 10-26% of users update their status, comment, “like” or send private messages at least once a day. But more specific to our study, how does the use of Facebook influence users’ emotional states? The Pew report finds that Facebook users are more trusting than others, have more close relationships, get more social support and are more politically engaged than most people [18]. Does this mean that they are happier or turn to Facebook when they need this kind of support?

Pea et al. [43] used a large, online survey of girls from North America aged 8-12 and examined the relationships between social well-being and young girls’ media use—including video, games, music, reading/homework, e-mailing/posting on social media sites, texting/instant messaging, and talking on phones/video chatting and face-to-face communication. These researchers found a strong negative association between personal communication in media and social well-being. For example, using the phone, chatting, listening to music, reading and especially watching video were highly correlated with negative social well-being. Media multi-tasking was also correlated with negative social well-being. On the other hand, face-to-face communication was strongly associated with positive social well-being. While these findings have direct implications for pre-teens’ social well-being, do they translate into mood effects in the workplace?

Kramer (2012) did a large-scale study of emotional contagion by studying Facebook status updates [30]. His research suggested that if someone from your social network made a status update with emotional content, the friends of the poster are more likely to post in a similar emotional vein. His original group of participants included one million random Facebook users. He found that this effect was long-lasting (lasting up to 3 days after the original post) and held when controlling for emotional expressions by posters and their friends in the past. This study was important because it may have demonstrated the contagion of emotion through indirect textual posts in social networks (though of course it could not control for face-to-face interactions with close friends that might also be your friend in Facebook). The speculation proffered by the

author is that these public expression strategies might help users maintain psychological health, by inviting friends to share in each other’s joy or by gaining social support when needed. It was also conjectured that sharing negative emotions on Facebook might be important for garnering feelings of closeness.

There may also be gender differences to consider. For instance, Kivran-Swaine et al. [29] analyzed the language used on Twitter exchanges in addition to aspects of users’ networks, to analyze the influence of gender on emotion, while controlling for the strength of connection between the users. Their findings showed that women expressed positive emotions more than men, especially when exchanging tweets with other women.

According to reasoning by Hampton and Wellman [19], Facebook might enhance current, place-based community and help generate social capital, which may help explain why so many people use it on a frequent basis. Another study has shown that using Facebook may actually boost your self-esteem, largely due to users and their social networks portraying their best possible selves [16]. Yet it is unclear whether these factors could also positively impact mood in the workplace.

Research questions

In this study we ask the following two research questions.

1) *How are Facebook (FB) use and face-to-face (F2F) encounters related to mood as it fluctuates throughout the day?* Mood varies throughout the day depending on workload changes, task engagement, interactions, and breaks that one may take. Measuring mood at a single point in time fails to capture the dynamic nature of interactions at work and how they affect mood. Continually tapping into mood as the environment and context change can provide us with insight into how specific phenomena (interactions, computer use) affect mood. It also enables us to capture mood while the experience is still recent in memory [21]. Therefore, in this research question we examine how online and offline interactions may impact mood changes throughout the day. As interactions may occur in a context of dynamic task-switching [17] we also examine how multitasking influences mood throughout the day.

2) *How are the amount of FB use and F2F encounters over the course of the day related to one’s mood state at the end of the day?* In this research question, we are interested to examine whether FB or F2F encounters have a longer temporal effect such that at the end of the day, one’s mood might be affected. Mood at the end of the day is important to consider as mood in work and home life can have carryover effects [56]. In particular, we are interested in whether the amount of FB or F2F encounters could influence a *change* in mood over the course of the day. Again, as interactions occur in a context of multi-tasking, we also examine factors related to task-switching.

VARIABLES TO ASSESS MOOD IN THE WORKPLACE

An assumption in studying mood or "feeling" is that it can be broken down into different dimensions that are consciously accessible [46]. A range of variables have been used to assess mood [46]. As our focus was on interaction and mood in the workplace, we considered the following dimensions to be the most relevant: valence, engagement, and challenge. Since personality's effects have been well studied on mood, we felt it was important to consider personality traits in our exploration. Finally, given the potential of disruption to ongoing work caused by interactions, we incorporate prior knowledge on how task-switching behavior may impact a user's affective state.

Dimensions of mood

We selected *Valence* as a measure to capture the positive (e.g., happy, upbeat) and negative (e.g., sad, gloomy) affective dimensions of an emotion [5]. Informed by the study of Pea et al [43], who examined media and face-to-face interactions, we deemed it important to understand the type of valence associated with offline and online interactions. The valence measure has been validated in assessing positive and negative affect. Steptoe et al. [51] measured affect using a self-report sampling method (as in the current study) and validated it with physiological measures of cortisol samples and heart rate monitoring. Positive and negative affect have been examined in a range of different contexts in the workplace. See [3, 21] for reviews.

We selected *Engagement* as a measure to capture the degree to which people felt involved in or distracted from their work, particularly relevant in information work where people are constantly interrupted and switch tasks [10, 17]. We follow the definition of Schaufeli et al. [48] who defines engagement as "*a positive, fulfilling, work-related state of mind that is characterized by vigor, dedication, and absorption*". Experience-sampling studies typically query subjects with either 'engagement', 'concentration', or 'involvement' in an activity to capture the degree of engagement [21]. Others have studied and visualized self-reports of engagement to help users reflect upon their work activities and mood using various sensors [40]. We were motivated to build upon and extend this work. For a review of how engagement has been used in self-reports, see [21].

We also focus on *Challenge*, as we felt that when someone in the workplace is faced with juggling interactions and work demands, then this could at times create a feeling of being challenged, e.g., due to time pressure [37]. This may especially be the case if online or offline interactions are viewed as distractions as opposed to benefits [41]. One's perception of 'challenge' can be dynamic, depending on the activity; interacting with someone face-to-face during a coffee break might yield a different feeling of challenge compared to dealing with an interruption amidst other task activities. We define challenge as the amount of mental effort involved in performing an activity. The construct of

challenge in the workplace has long been emphasized for its significant contribution to job satisfaction (e.g., [22]). The feeling of challenge has been studied extensively and has been validated as part of the experience of "flow", or optimal experience [21].

Effects of personality on mood

Personality, as related to interactions and mood, has long been a topic of interest, with recent studies beginning to address online interactions. The Big Five dimensions of personality have been widely employed as a measure [39], as they are well-validated, and consistent and comprehensive in scope [13]. The Big Five characterizes personality using five different traits [39]. *Agreeableness* refers to cooperative behavior, as well as deferring to others during a conflict. *Conscientiousness* refers to the propensity for planning and to seek high achievement. *Extraversion* is the tendency to want to be with others, to have strong social skills, and to seek social stimulation. *Openness to Experience* refers to being open to change and variety and seeking diversity. *Neuroticism* is the tendency to feel guilty, depressed or anxious.

In terms of mood, Neuroticism is generally associated with negative affective states while Extraversion is associated with positive affective states (cf [54]). Some research has addressed the relationship of personality with face-to-face and online communication. Extraversion was shown to be positively correlated with using the Internet to maintain both face-to-face and remote friendships [53]. Facebook users were found to score high on Extraversion [47], and social network site use [6]. Conscientiousness has been shown to be negatively correlated with time spent on Facebook [47] while Neuroticism was found to be positively correlated with time spent on Facebook [47]. Openness to Experience was positively correlated with social network site use [6].

Thus, though positive and negative affect are generally related to specific personality traits, the results relating personality to communication, especially online social network use, is mixed. As prior studies show correlations with Extraversion, Conscientiousness and Openness, we examined these personality traits in our study.

Effects of interruptions, email and task switching on mood

Broadly speaking, both Facebook and face-to-face interactions typically interrupt the flow of ongoing work at the workplace, which can in turn affect mood. A large body of prior work has explored the effects of interruption on a user's affective state, mostly focusing on negative affect such as frustration, anxiety and annoyance caused by inopportune interruptions [1, 2, 24, 57]. McFarlane and Latorella demonstrated that interruptions that are unpredictable and cannot be controlled result in more stress and affect task performance [41]. Mark et al. [37] also showed that interruptions can lead to increased stress and higher frustration.

On the other hand, external interruptions to ongoing work caused by emails and instant messages have been shown to have positive benefits including supporting near instant communication [9, 11, 32], maintaining awareness of peripheral information [34], reminding upcoming activities [12] or helping users perform complex tasks [33, 45]. Such benefits can lead to positive affect. Self-interruptions can also have positive or negative impact on an individual [27].

Other studies have looked at how interruptions from digital media such as email or IM notifications, or physical interruptions such as phone calls or face-to-face interactions, cause people to continue to be distracted by switching tasks with effects on task performance [10, 25, 26]. Notifications also are associated with emotional experiences and are correlated with types of notifications people would like to receive in the future [42]. Email use in particular has been found to be associated with an increase in stress [37, 38].

Thus, it is unclear how FB and F2F interactions, and digital media use in general, might influence mood in the workplace. To the best of our knowledge, no study has looked at the effects of social interactions on mood in the context of the workplace. As it is an open question, based on this prior body of work, we examine FB and F2F interaction, as well as task switching of applications and documents, along with email usage. Our broader goal is to understand factors that impact mood at work.

RESEARCH STUDY

To understand effects of FB and F2F interactions on mood in the workplace, we conducted an *in situ* study. The research was conducted in the fall of 2012 at a large U.S. corporation.

Participants

Participants were recruited primarily from volunteers who responded to email advertising done throughout a research division in the company. The rest of the participants were recruited through convenience sampling or snowball sampling, (i.e., recommendations of names from people who participated.). Our criteria for recruitment were that people should be FB users and that they use the Windows 7 operating system (which was compatible with our logging software). Thirty-two people (17 females, 15 males), volunteered to participate. This sample is over double that of samples used in similar *in situ* work tracking studies [10, 17, 38]. We feel that the data collected from 32 people over five full work days was sufficient for enabling us to gain a representative sample of their mood in their daily work environment.

All participants were knowledge workers. Most participants were involved in research (15), but there were also managers, admins, engineers, a department director, a designer, and consultant.

Methodology

Following a paradigm of precision workplace shadowing [17, 38], our goal was to capture as complete a picture as possible about online workplace behaviors and mood. Each participant was observed for a period of five days. For most participants, this was Monday through Friday, i.e., a regular work week. Some participants traveled during the week or missed a day for other reasons; in these cases, they made up the missed day (in most cases) the following week.

We used mixed methods for our data collection: computer logging was used to capture online actions, a wearable SenseCam camera [23] was utilized to capture face-to-face interactions, experience sampling probes were used to capture self-reported moods throughout the day, and a series of surveys were collected for other subjective and demographic measures. On the day before the participant began the study (usually a Friday), the computer logging software and experience sampling software were installed on their computer. The study and tracking approaches were explained to the participant. Participants were assured that their data would be private and aggregated, that no content would be retraced to their information, and that they would remain anonymous. They were also assured that their data would be deleted in a timely manner.

Participants were instructed to work as they normally would throughout the workday. They were instructed to answer the (experience sampling) probes when the probe windows popped up on their computer screens, but they also could cancel the probe window when they chose. We emphasized that it was important to answer the probe questions as accurately as possible. Participants were told that at any time they could turn off the SenseCam camera. In the post-study interviews, 11 participants reported that they turned the camera off when they left the office for brief periods (e.g., for meetings, a demo, and a doctor's office). In these cases, we did not collect probe or logging data either. For two people we lack SenseCam data for ½ day each.

Measures

Below we explain the details of the measures taken. Table 1 provides a summary of the measures and their explanations, along with abbreviations used to refer to them in the paper.

Data collection: sensors and experience sampling

In collecting data we had to decide between using highly precise sensor-based data and human observation data which is more effective in capturing the context of the participant's work. Previous ethnographic studies that track workplace behavior, e.g. [17], while capturing rich data, are very labor intensive for capturing precision data, i.e., users' actions tracked to the second. Automatic data collection by sensors, though lacking contextual information and intentional data that ethnography provides, enables the collection of a wider array of data, with more participants simultaneously, and at a higher precision level than human ethnographic observation. Thus, the choice of using sensors to capture human behavior as opposed to ethnographic

Measure	Explanation	Abbrev.
Computer Logging		
FB use (seconds)	The amount of time spent in a web browser where a Facebook page is in the foreground tab.	FB
Email use (seconds)	The amount of time an email is open and in the foreground, whether one is reading a received mail, composing a new mail, or replying or forwarding.	Email/Use
Email/Calendar (seconds)	The amount of time any part of the Email/Calendar Application is open and in the foreground, including email, calendar, contacts, tasks, etc. Email usage in Email/Cal is distinct from usage in Email/Use. Email/Use refers to operations of reading and writing, whereas Email/Cal refers to simply viewing the inbox.	Email/cal
Document switches (counts, per unit of time)	The number of document switches <i>within</i> an application, e.g. within Word or Excel or Internet Explorer. In web browsing, each new page is a document switch.	Doc
Application switches (counts, per unit of time)	The number of switches <i>between</i> applications, e.g., from Internet Explorer to Word.	App
SenseCam		
F2F interactions (counts)	The SenseCam captured images on average once every 15 seconds.	F2F
Experience Sampling Probe		
Valence (-200 to +200. Neutral = 0)	Ranging from negative to positive affect.	Valence
How Engaged (0=not at all to 5=high)	The extent to which people feel involved with or distracted from work	Engaged
How Challenged (0=not at all to 5=high)	The amount of mental effort involved in performing an activity	Challenged
Surveys		
PANAS	Rating scale of mood of positive (PA) and negative (NA) affect dimensions [55]; deployed at beginning (BEG) and end (END) of each day	PA-BEG, NA-BEG PA-END, NA-END
Big 5 traits	Personality inventory [39]	Extroversion Neuroticism Conscientiousness
Demographic info	Age, gender, job role, education	

Table 1. Summary table of measures, explanations and their abbreviations.

approaches involves a tradeoff between precision and contextual richness. Since for this study the precision of data was central to understanding mood changes we chose for our methodology the use of sensors. To compensate for the lack of context that human observation could have provided, we collected participant self-reports to supplement our automated data with the participant's perspective. We collected the following data:

Mood throughout the day: Experience sampling

To collect mood data throughout the day we used the experience sampling method. Experience sampling is designed to capture people's perception of daily life as it changes throughout the day. This method has been proven to have internal validity [8] as well as external validity [21]. Experience sampling works well paired with computer

logging as it provides information on how the participant is experiencing the events and context. Experience sampling has been used in a large number of studies and particularly has been used for measuring mood in the workplace: some example studies examined work and home life balance [56] and time pressure [52]. For a review see [21].

Experience sampling was done with custom built software that presented a probe, a small pop-up window on the computer screen, to participants using predetermined sampling rules. We used a hybrid interval-contingent and event-contingent sampling approach [21]. The sampling occurred whenever a user left email after being active in that application for at least three consecutive minutes, or in FB after a full minute of uninterrupted use. Sampling also

was triggered whenever a user logged into Windows or unlocked the screen saver (event-contingent). If fifteen minutes passed without a sampling, then a probe was triggered (interval-contingent).

The probe presented the instructions "Please rate how you feel right now". We used rating scales as is commonly used in experience sampling approaches [21]. To measure Valence, participants saw a sliding scale which corresponded to a range of -200 (negative affect) to +200 (positive affect) and were asked to click with their cursor on that point that best expresses their feeling "right now". To measure Engagement, participants were asked 'How Engaged Were You?' using a 6-point Likert scale (0=Not at All; 5=Extremely). To measure Challenge, participants were asked 'How Challenged Were You?' using the same Likert scale. Participants were asked if they just had any face-to-face interactions, and if so, a second screen was shown, asking whether the participant had a scheduled meeting. The timestamp when participants submitted the probe was recorded.

Beginning and end of day mood: PANAS

To answer the second research question, we needed to collect overall mood data at the beginning of the day and at the end of the day so that we could quantify any changes. We deployed surveys at the beginning and end of each day to measure mood using the PANAS scale [55], a well-validated 20-item inventory of mood which is comprised of two scales to measure positive and negative affect. Items included feelings such as interested, excited, distressed, upset, and irritable. Participants were asked to rate to what extent they felt that way at the present moment on a scale ranging from *very slightly/not at all* to *extremely*.

Facebook interactions: Computer logging

Online interactions were logged with a custom-built application that captured all activity in the Windows Operating System. Captured activity includes beginning and end times for the lifespan of every window, and the beginning and end times for every instance of every foreground window. Computer sleep mode, mouse and keyboard activity were also logged, so that periods of time in which an application was in the foreground window, but the user was not actively using the computer, could be ignored.

Note that we were unable to capture activities that occurred within a window itself, e.g., capturing what a person was looking at while on FB or any other application due to privacy and technical limitations. While there are APIs that can collect data on what one posts – statuses, comments, photos, etc., there is no public API that allows one to track actions to the second on Facebook. Even such APIs would provide access to only a small fraction of what one does on Facebook and would miss interactions that involve scanning for awareness which can be only detected via over-the-shoulder shadowing. We therefore focused on measuring the total time one spends on FB as a holistic

measure of FB interaction, though we hope to be able to capture more fine-grained interaction data in future research.

Face-to-face interactions: SenseCam

F2F interactions were measured through SenseCam [23], a lightweight wearable camera that participants wore around their necks. The camera automatically takes a picture and stores it locally, and as soon as the image is processed and saved the next picture is taken. The average length of time between photos is 15 seconds. SenseCam images were processed by a face detection module, a publicly available application produced by Microsoft Research (<http://research.microsoft.com/en-us/projects/facesdk/>). It is important to note that with this software, we cannot distinguish whether the faces were the same person or not. Therefore, the counts in our F2F variable should be considered as a proxy for amount of F2F interaction over the course of the day, and not necessarily *distinct* interactions. It is thus a measure of how much interaction a person experienced, and not precisely how many different interactions one engaged in.

RESULTS

We first present an overview of results of the data collected, the probe responses measuring mood, and then an overview of FB and F2F interactions.

Data overview

Our 32 participants were observed for 5 days each, for a total of 160 person-days, or a total of 1,509 hours of data collection. Our computer logging software collected a total of 91,409 computer window switches. We collected 2,809 experience sampling probes and analyzed 204,922 SenseCam photos.

Mood: probe responses

Our 32 participants averaged 17.56 probe responses per day, for an average of 87.8 probe responses per participant. The average Valence rating over participants was 38.83 (on a scale of -200 to +200), showing a net positive affect. Females ($M=44.78$, $sd=74.98$) reported significantly higher Valence than males ($M=32.75$, $sd=62.30$), $t(2807)=4.62$, $p<.0001$. The average Engaged rating over participants was 3.01 ($sd=1.37$), on a scale of 0-5 (high). Females ($M=3.09$, $sd=1.37$) reported being significantly more Engaged than males ($M=2.93$, $sd=1.38$), $t(2808)=9.25$, $p<.004$. The average Challenged rating over participants was 1.82 ($sd=1.42$) on a scale of 0-5 (high). There was no significant difference between females ($M=1.78$, $sd=1.36$) and males ($M=1.86$, $sd=1.47$), $t(2807)=1.43$, $p<.15$, in feeling Challenged. Thus, in our sample females reported higher positive Valence, and reported to be more engaged in their tasks than males, throughout their workday.

FB and F2F interactions

We next present an overview comparison of FB and F2F interactions over the course of the day. Table 2 shows average daily FB use in seconds and F2F interactions, broken down by age and gender.

	N	FaceBook (sec.)	F2F (SenseCam counts)
Females	17	715.14 (1662.65)*	78.51 (81.16)
Males	15	320.33 (827.64)*	74.62 (90.04)
Age			
< 30	6	941.83 (2536.02)	37.33 (56.13)**
30-40	16	425.16 (830.71)	93.83 (95.62)**
> 40	10	454.58 (830.71)	72.18 (73.55)**
Overall mean	32	529.92 (1348.19)	162 (76.69)

Table 2. Means (S.D.) of daily FB use and F2F interaction, as measured by SenseCam counts, N=32 subjects, each measured over five days, *=p<.001, *=p<.05.**

A 2 (Gender) x 3 (Age) ANOVA conducted on the dependent variable of FB shows a significant Gender difference ($F(1, 161)=5.39, p<.02$), and a trend showing Age x Gender interaction ($F(2, 161)=2.64, p<.08$). Age is not significant. Females use FB over twice as long on an average day as males.

A 2 (Gender) x 3 (Age) ANOVA conducted on the dependent variable of F2F interactions shows a significant effect of Age ($F(2, 162)=5.19, p<.007$, but no Gender, or Age x Gender interactions. In sum, people in the age range of 30-40 had the most F2F encounters during the day on average, with people under 30 having the least. In contrast, people under 30 had the most FB usage, with ages 30-40 the least. Work roles could somewhat explain the difference. Participants under 30 were all researchers (researcher, intern, postdoc) whereas participants 30-40 had more of a range of positions (researcher, intern, manager, admin, designer, and consultant). Younger participants may use social media more than their older counterparts, and this might have an effect on their number of F2F interactions.

Comparing activities in 5-minute time units, time spent in FB is weakly correlated with both App switching ($r=.09, p<.0001$) and Doc switching ($r=.11, p<.0001$), $N=37,788$. F2F is very weakly correlated with both App switching ($r=.05, p<.0001$) and Doc switching ($r=.08, p<.0001$), $N=37,788$.

Mood throughout the day: Valence, Engagement, and Challenge

Our first research question addressed how FB use and F2F interactions influence mood throughout the day. We report the results of three mood states: Valence (positive and negative affect), and feelings of Engagement and Challenge in the current activity.

We collected data on the same participant for five days. To account for the nested interdependence in our data, we ran linear mixed models in SPSS using random and fixed

effects, and did this for all three mood measures. As we had no a priori notion of what variables might be associated with mood change, the ideal procedure would be an automatic model fitting based on selecting those variables that would result on the best fitting model. As SPSS does not have an automatic model building procedure for linear mixed models, we built the models by hand. We emulated a backward elimination procedure as in stepwise regression, where we started with all variables in the model and then by hand gradually eliminated different combinations of variables until we found the best fitting model based on the BIC criterion¹. We tested variable measures in different time units (1, 5 and 10 minutes) prior to each probe response and included the results that showed the strongest correlation in the model.

An R^2 statistic for linear mixed models must account for the variance explained by both the fixed and random effects; however, there is no standard method for specifying an R^2 in these models [15]. To provide a sense of how much variance the model explains, we ran a linear model including only fixed effects to get an R^2 value. By not including random effects (participants), this of course will underestimate the amount of variance explained but we feel it is a reasonable estimate since the random effects are small.

We tested models that included all the variables shown in Table 1. As some variables were not normally distributed, we did a log transformation on these variables: F2F, FB, Email/Use, Email/Cal, App and Doc.

Influencing Valence throughout the day

We first report the results of the model for Valence change over the course of the day. Table 3 shows the independent variables in the model that best fit Valence as a dependent variable. The model shows that the more F2F interaction in the 5 minutes prior to the probe (i.e., F2F counts as

Valence model	β	t	p
Intercept	-32.37	-1.06	.30
F2F prior 5 min. (counts)	4.90	2.44	.03
Email/Use prior 5 min. (sec.)	-3.41	-2.85	.005
Big 5 Extroversion	2.69	2.32	.03

Table 3: Beta coefficients of variables for best fitting model for Valence throughout the day. N=2809 cases.

¹ In linear mixed models, Schwarz's Bayesian Criterion (BIC) is the criterion used to find the best fitting model [49.]. The lower the score, the better the fit of the model. The absolute number itself is not meaningful—the BIC is used to compare between models and is a well-established metric of model selection.

measured in the SenseCam photos), the higher (i.e., more positive) the Valence measure. Email/Use, on the other hand, shows an inverse relationship with Valence: the *lower* the seconds of email use in the 5 minutes prior to the probe (i.e. reading or writing emails), the more positive the Valence measure. There is also a significant positive relationship with the Big 5 Extroversion personality score and Valence: the more extroverted participants are, the more positive is the Valence measure. There were no significant interactions. FB was not found to impact Valence. There was no significant difference in Valence if one had a scheduled meeting or not before the probe. The R^2 of a linear model of the fixed effects alone is 14.4% (see explanation above).

Influencing Engagement throughout the Day

We next focus on variables that might influence Engagement over the course of the day. Our dependent variable was Engagement, as measured by participants' responses to the probe, "How Engaged Were You?" on a 6-point scale ranging from 0='not at all' to 5='extremely'. Table 4 shows the best fitting model.

Here, the model shows that the *fewer* seconds of FB use prior to the probe, the more Engaged one reports. In contrast, the *more* F2F interaction prior to the probe, the more Engaged one reports to be. Contrary to Valence, the more time spent in Email/Use, the higher the reported engagement. The more task switching (as measured by App), the more engaged one reports to be. Email/Cal use is inversely related to Engagement. Interestingly, Conscientiousness, from the Big 5 personality inventory, is positively associated with Engagement. No interactions were significant. Though linear mixed models in SPSS do not report multi-collinearity, a regression analysis of these factors shows all variance inflation factors (VIF) to be <1.1, indicating that multi-collinearity is not a problem. The R^2 of a linear model of the fixed effects alone is 30.6%.

Engagement model	β	t	p
Intercept	1.97	3.32	.002
FB use prior 10 min. (sec.)	-.10	-3.29	.004
F2F prior 5 min. (counts)	.08	1.93	.05
Email/Use prior 5 min. (sec.)	.16	5.63	.0001
App prior 10 min. (counts)	.10	3.03	.002
Email/Cal prior 10 min. (sec.)	-.08	-3.60	.0001
Big 5 Conscientiousness	.04	2.05	.05

Table 4: Beta coefficients of variables for best fitting model for Engagement throughout the day. N=2809 cases.

Influencing Challenge throughout the Day

What leads people to feel challenged throughout the day? Our dependent variable was Challenge, as measured by the

probe question: 'How Challenged were you?' using the 6-point Likert scale. Table 5 shows the independent variables that produce the best fitting model.

The model shows that FB use is inversely related to Challenge: the more one uses FB, the *less* challenged one feels. Email/Use is positively related to Challenge: the more time spent email reading/writing, the more challenged one self-reports. Task switching (as measured by App switches) is positively related to feeling challenged. However, Email/Cal use is inversely related to feeling challenged. One's negative mood at the beginning of the day (as measured by the PANAS NA BEG), is positively associated with feeling challenged throughout the day.

We also find a significant Age x Gender interaction but no other interactions. In Table 5, the beta coefficients show that females 30-40 feel positively challenged; all other Age x Gender levels show that participants feel negatively challenged. As Table 6 shows, for those under 30, males

Challenge model	β	t	p
Intercept	1.07	2.70	.007
FB use prior 10 min. (sec.)	-.18	-3.99	.001
Email/Use prior 5 min. (sec.)	.11	2.98	.005
App prior 10 min. (counts)	.08	2.48	.013
Email/Cal prior 10 min. (sec.)	-.06	-2.89	.004
PANAS NA BEG	.86	2.88	.004
Age X Gender	<30, F: -.71	1.65	.04
	<30, M: -.18		
	30-40, F: .07		
	30-40, M: -.68		
	>40, F: -.80		
	>40, M: 0*		

Table 5: Beta coefficients for best fitting model for Challenge throughout the day. N=2809 cases. *=This parameter is set to 0 because it is redundant.

Age	Gender	Mean (SE)
<30	F	1.38 (.27)
	M	1.91 (.40)
30-40	F	2.16 (.16)
	M	1.41 (.24)
>40	F	1.29 (.37)
	M	2.09 (.21)

Table 6: Mean (SE) of Age x Gender levels that influence How Challenged one is throughout the day.

report being more challenged than females; for those 30-40, females are more challenged than males; and for those over 40, males are more challenged than females. The variance inflation factor is < 1.8 for all variables indicating that multi-collinearity is not a problem. The R^2 of a linear model of the fixed effects alone is 39.6%.

We summarize the results of our first research question. The more F2F interaction one has, the more positive is one's Valence rating and the more one feels Engaged. The longer one spends in FB, the less Engaged and Challenged one feels. Length of time of Email/Use is consistently a strong influence on all three types of mood: negatively related to Valence, and positively related to Engagement and Challenge. Task switching is positively related to both Engagement and Challenge. If one starts out the day with a negative affect, then this shows a spillover effect in making people feel more challenged throughout the day. Personality traits are also associated with mood: the higher the Extroversion score, the more positive the Valence, and the higher the Conscientiousness score, the higher the Engagement rating.

Changes in mood at the end of day

Our second research question asked what factors would be associated with a person's mood at the end of the day. Would cumulative time in FB and amount of F2F interactions have an effect on one's mood at the end of the day? What other types of user actions throughout the workday make one feel more positive or negative by the end of the day?

Positive mood at the end of the day

To investigate positive mood at the end of the day, we looked at the *change* in positive affect over the course of the day, computing a dependent variable based on [PANAS PA-END score – PANAS PA-BEG score]. We were particularly interested to see if FB use or F2F interactions were associated with a more positive mood at the end of the day compared to the beginning of the day. We examined a dataset consisting of each participant's measures totaled for each day. We ran a stepwise regression in SPSS entering the following variables, controlling for individual differences: FB, F2F, Email, Email/Cal App, Doc, App, Age, Gender, Sociability, FB Import, Engaged, and Challenged. Individual differences were not found to be significant. The following model best fit the data, as shown in Table 7: $F(2,99)=9.99$, $p<.0001$, $R^2=16.8$. There is no significant Engaged x FB interaction.

Positive End of Day Mood	β	t	p
Constant	-13.13	-4.31	.0001
How Engaged	3.76	3.89	.0001
FB Use (seconds)	.778	2.50	.01

Table 7: Beta coefficients to model the change in positive affect at the end of the day.

This model shows that the more one feels engaged in their activity during the day, the more positive one feels at the end of the day (compared to the beginning of the day). FB also plays a role in influencing affect over the course of the entire day: the longer one spends in FB over the course of the day, the greater the increase in positive affect. Time in FB contributed 5.3% of the R^2 , i.e. the variance explained, of the change in affect.

Negative mood at the end of the day

To investigate what might be associated with negative affect at the end of the day, we computed a dependent variable based on [PANAS NA END score – PANAS NA BEG score]. Using the same dataset as positive mood at the end of the day (see above), and entering the same variables into a stepwise regression analysis, we found none of our measures to significantly influence negative mood at the end of the day.

DISCUSSION

In this study we examined the open question of how FB use and F2F interaction influence workplace mood. We studied influences on mood from two perspectives: how mood fluctuates throughout the day and how mood is experienced at the end of the workday. Our study provides initial evidence that FB and F2F both influence positive affect, albeit in different ways. Moreover, workplace interactions, as discussed, generally occur within a broader context of other task activity and we found that email and task-switching influence workplace mood as well. Demographic and personality variables also contribute to explaining workplace mood.

Our results suggest that online and offline interactions serve different purposes in the workplace in terms of influencing mood. F2F interactions are associated with positive affect throughout the day whereas amount of FB use contributes to an overall positive feeling at the end of the day. Our results further show that throughout the day, F2F interactions were positively associated with Engagement whereas FB use was inversely associated with Engagement and Challenge. F2F showed no relation to Challenge.

Our findings show that when people are engaged in F2F interactions, it makes them feel more positive. F2F interaction involves different stages: an opening phase (e.g., greeting, adjusting proximity), the interaction, and a closing phase (parting rituals), which contributes to creating a social commitment to some degree [28]. FB, on the other hand is negatively associated with engagement and challenge. FB is an online interaction that can be done quickly, in a "grazing" fashion, without a greeting, involvement, or closing stage. This can explain why FB is not associated with high engagement or challenge, though of course our users could have chosen to go to FB precisely because they were in a state of low engagement in the first place!

To understand the FB results more holistically (i.e., that it influences positive affect at the end of the day, and involves low engagement and low challenge), we can be informed by the results of the Engagement variable, also associated with positive affect at the end of the day. Engagement was a fairly strong influence of end of day positive affect, explaining most of the variance. In our post study interviews, nearly all participants reported that being productive puts them in a good mood. Engagement in work could be equated with feeling productive.

How are FB use and Engagement then tied together to influence positive affect? FB use is weakly correlated with both App switching and Doc switching which suggests it may be used in a context of high task switching. Consistent with the idea of grazing, people can quickly move in and out of FB. As FB was not associated with high engagement or challenge, together with its use during task switching, it suggests that FB may be a "light" interaction experience. If people are also highly engaged in their work for that day, then FB could serve the purpose of offering a "break" from other work. High engagement in work, along with light breaks as FB affords, contribute then to people being in a positive mood at the end of the day.

Negative affect at the beginning of the day, as measured by the PANAS survey, also influenced feeling challenged throughout the day. This spillover effect that we found extends the work of Marco et al. [35] who, using an experience sampling study, found that a person's negative personality disposition leads to a feeling of distress in handling events throughout the day.

What makes people feel happy at work? Our results thus suggest that having F2F interactions and being engaged in work influences positive affect. However, "light" interactions of FB (as measured by negative challenge and engagement) are also important in contributing to a positive affect at work. Our result showing that F2F influences positive affect extends the findings of Pea et al. [43] who focused on moods of adolescent girls. Our results in an *in situ* workplace environment also show that F2F encounters impact positive affect.

Email, task-switching and mood

While our main focus was on examining FB and F2F interaction and mood, it is important to consider that these activities are done within a context of digital media use in the workplace. Email was a factor that surfaced as significantly influencing all three mood measures throughout the day. We found that the more time spent reading and answering emails (Email/Use) throughout the day, the lower was one's positive affect. Studies of email use have uncovered that it leads to stress [37, 38]. Our study additionally shows that reading and responding to emails is associated with feeling engaged and challenged. Responding to email may disrupt ongoing work, making resumption of tasks more challenging [26]. Email also

influences negative affect. Put simply: reading a lot of email at work puts people into a "bad mood".

If we consider email as a communication tool we can examine how it compares with F2F and FB as communication mediums. F2F interaction and Email/Use both elicit similar results of feeling engaged in the workplace. F2F requires a degree of engagement to attend to verbal and nonverbal information and also to respond to the conversation partner [28]. Reading and responding to emails also requires a certain degree of engagement as it involves communicating with another.

On the other hand, FB and Email/Cal both showed similar results of being inversely related to feeling engaged or challenged. Checking one's Inbox and calendar (Email/Cal) are aspects of task and time management which involves gaining quick awareness. FB actions of reading status updates can also be used to gain a quick awareness of friends' status. Future research could distinguish FB activities in a more fine-grained manner to examine whether distinct activities are associated with different aspects of mood.

Task switching, as measured by App switching, was positively related to both Engagement and Challenge. We might expect that when one is task switching one would be engaged in this activity, as this involves constantly shifting focus and it can be challenging to reorient back to an interrupted task [17]. This result extends previous work on multitasking which shows it is related to stress [37].

Personality and mood

We found that personality traits influence mood throughout the day. Extraversion has been previously found to be associated with positive affect in single self-reports [31, 54]. Our study demonstrates that Extraversion influenced Valence using continual measurements in the context of a dynamic workplace. We also found that Conscientiousness was positively related to Engagement as it was measured throughout the day. Though no personality study has ever directly addressed Engagement, we would expect these results. According to the Big 5 Inventory, self-discipline and achievement-striving are facets of Conscientiousness [7] which we expect are related to feelings of Engagement. Therefore, our results contribute to studies of personality by showing it influences mood as a person's context changes.

Gender and mood

Females use FB over twice as long on average per day as males. Females report over the course of the day as having significantly more positive Valence and they are significantly more engaged in work than males. Our results extend the findings of Kivran-Swaine et al. [29] who found that females express more positive emotions than males with Twitter use. Our results together suggest that females in the workplace use FB more and are happier (though these two results do not imply causality).

We found an Age x Gender interaction with the Challenge measure: in both the younger and older age groups, males report being more challenged than females; in our mid-range age group, females report being more challenged than males. We find this result important as it reveals that gender and mood effects in the workplace are related to age. We hope that this result can lead to more detailed examination of gender differences and work.

Alternative explanations to mood rating

We consider alternative explanations to our mood results. Demand characteristics are always a potential explanation of the results, i.e., that participants rated their mood according to how they believed the researcher wanted them to behave. However, we do not believe that demand characteristics played a major role. First, it was not clear to participants what kind of mood they should expect to report. Second, there was variability in mood assessments. If people presumably believed that the researcher was looking, for example, for positive (or negative) affect, we would expect that mood would be rated consistently throughout the day, and it was not.

Another possible explanation of our result showing no end of day mood effect for F2F is that F2F interaction creates positive feelings that dissipate very quickly or are not remembered at the end of the day. FB, on the other hand, could create feelings that are longer lasting throughout the day. A mechanism that could lead to long lasting feelings is that FB use constantly reminds people of close friends who are remote. More research is needed to test the notion of the temporal span of feelings with F2F interaction and FB use.

Sensors and human observation

A contribution of our study was to show that sensors are a viable means for capturing *in situ* workplace behavior. Sensors enable the continual capture of behavior with minimal disruption for the participant. Another advantage of automated capture of behavioral data is that it can be scaled up enabling the investigation of more complex phenomena such as workgroup or even organizational behavior. Though our technology did not enable us to capture fine-grained details of FB use or types of F2F interaction, we hope that our study can spark research in this direction.

Limitations

Our participants were all highly educated (at least having a Bachelor's degree) and about half were researchers. They thus represent highly skilled knowledge workers. We therefore can only generalize our results to similar types of workers. The use of researchers as participants has been used in other activity tracking studies, e.g. [10, 38]. However, we believe that task characteristics of our participants are very similar to what is found in many kinds of information work: dealing with multiple tasks, deadlines, and heavy reliance on information technology at work.

A known issue with the Experience Sampling method is that the probe can be a source of interruption [21]. However, in the post-study interviews, participants did not report this as a problem. We believe that the reason is because the probe was able to be answered in seconds. Another potential limitation is that raised by Columbetti [5] who argues that a positive-negative valence scale misses complexity as a measure of affect. However, studies such as Steptoe et al. [51] have carefully validated this dichotomous valence measure and we feel that the level of discrimination was adequate for the goal of our study.

Another limitation was our use of the SenseCam to measure face-to-face interaction. As explained, the SenseCam can only be considered a proxy for amount of F2F interaction; the face detection software that we used cannot distinguish unique faces. Therefore, the F2F interaction measure should be regarded as "amount" of interaction rather than distinct interactions. This is similar to measuring FB use, as we could not distinguish whether people were reading one post, or scanning over many posts. The SenseCam also would have failed to photograph faces if people were standing sideways when they spoke to someone. It also does not capture interactions that occurred within the 15 second window of time between SenseCam photo shots. Therefore, our measure of F2F interaction could have underestimated interaction counts.

CONCLUSION

Our results showed that both F2F interactions and FB use do influence positive affect in the workplace though differently. F2F involves more engagement in interactions, whereas the low engagement and challenge associated with FB use is consistent with a lightweight interaction that contributes, together with engagement in work, to making people feel good by the end of the day.

Our findings provide initial evidence of how social interactions affect mood at the workplace, suggesting the usefulness of incorporating social media platforms in the workplace as well as in promoting informal workplace interactions. This has important implications for decision-makers in the workplace who wish to balance interactions and task engagement with positive affect of employees.

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