Neurotics Can't Focus: An *in situ* Study of Online Multitasking in the Workplace

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ABSTRACT

In HCI research, attention has focused on understanding external influences on workplace multitasking. We explore instead how multitasking might be influenced by individual factors: personality, stress, and sleep. Forty information workers' online activity was tracked over two work weeks. The median duration of online screen focus was 40 seconds. The personality trait of Neuroticism was associated with shorter online focus duration and Impulsivity-Urgency was associated with longer online focus duration. Stress and sleep duration showed trends to be inversely associated with online focus. Shorter focus duration was associated with lower assessed productivity at day's end. Factor analysis revealed a factor of lack of control which significantly predicts multitasking. Our results suggest that there could be a trait for distractibility where some individuals are *susceptible* to online attention shifting in the workplace. Our results have implications for information systems (e.g. educational systems, game design) where attention focus is key.

Author Keywords

Multitasking; focus; information work; personality; stress; sleep; productivity

ACM Classification Keywords

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

INTRODUCTION

In today's information workplace, the surfeit of digital resources continually compete for people's attention. While switching among multiple online activities may benefit productivity, it can also distract people from the task-at-hand [5, 19]. Multitasking, the switching of attention among different activities, can be triggered internally (e.g., through boredom) or by external sources (e.g. email notifications). When a person switches between different activities frequently, their duration of focus on any one activity reduces as a consequence. In HCI, a fair amount of attention has been given to examining external influences on interruptions [5, 6, 15, 19] and to frequency of activity switching, e.g., [5, 15]. However, research has not explored individual characteristics to help understand multitasking behavior in the workplace.

It is not clear whether multitasking is an efficient behavior. In the workplace, activities were found to shift every three minutes, on average, including online work and interactions with people [15]. Evidence shows that switching attention between different tasks results in a 50% longer time to finish those tasks, compared to focusing on one task through to completion before starting the next one [13].

Some research suggests that cognitive differences could be an explanation for why some people multitask more than others. Heavy multitaskers were found to have less ability to filter out interference from environmental stimuli, which makes them more susceptible to distractions [27]. Individual differences also exist in people's ability to control attention [20]. Laboratory studies have investigated types of attention, such as selective or divided attention, or vigilance. However, to our knowledge, few studies have examined factors related to individual personality and situations that affect online focus duration in the real world setting of the workplace, cf [25]. We feel this is important given the extent to which digital media is used in information work.

In this paper we contribute to understanding multitasking behavior with empirical results that show that Neuroticism and Impulsivity relate to shorter online focus. A factor analysis revealed that a proposed trait described as lack of control may explain focus duration. This study is part of a larger project, HealthSense, tracking workplace behavior.

RESEARCH QUESTIONS

Multitasking can be viewed at different levels of granularity. From a broad perspective, multitasking refers to switching among different tasks or projects. At a more fine-grained level of analysis, multitasking can indicate switching of attention among different activities, which

CHI'16, May 07 - 12, 2016, San Jose, CA, USA

ACM 978-1-4503-3362-7/16/05...$15.00
DOI: http://dx.doi.org/10.1145/2858036.2858202

could be within the same task. This finer-grained perspective can be used as a lens to understand how people shift their attention when working online. Models of attentional resource allocation describe that people have limited attentional resources, and investing resources for some activities leaves fewer resources available to apply to other activities [35]. Based on a review of the literature, we expect that the following personality and physiological factors can affect resource use, reflected in online focus.

Personality: Neuroticism. In laboratory studies, higher Neuroticism relates to lower performance in selective attention tasks [30]. Neuroticism is a personality trait, assumed to be invariant (and to have a biological basis), is characterized by anxiety and is a response to emotional stimuli [9]. Neurotics are more prone to stress, report more daily problems, and tend to reanalyze prior events over and over in their minds [17]. Because Neuroticism is considered an invariant trait, the effects of an experience in one domain (e.g. home life) can carry over into another domain (e.g. the workplace) [12]. Investing mental resources, e.g., in reevaluating prior events, could result in fewer attentional resources available to focus on the current activity. The relationship of Neuroticism and attention has not been investigated in the workplace. We expect that Neuroticism might become manifest in the workplace as a shorter duration of focus on any computer screen.

H1: *Neuroticism is related to a shorter focus duration*.

Personality: Impulsivity. Impulsivity could also influence multitasking. While considered a personality trait, impulsivity is viewed as a heterogeneous construct (see [8] for a review). Generally speaking, people who are impulsive lack resources to restrain themselves from actions [8]. In the workplace, people who are impulsive may not be able to resist distractions, e.g., checking email or the Internet, leading to attention shifting and thus shorter focus duration on any single activity. We draw on the model of impulsiveness of Whiteside et al. [34] based on a factor analysis of previous models, which identified four impulsivity factors considered to be distinct psychological processes. We feel the most relevant factors for understanding workplace multitasking and attentional focus are the factors of Urgency and (Lack of) Perseverance. Urgency refers to the tendency to act on strong impulses (e.g. one cannot control cravings). (Lack of) Perseverance refers to one's inability to remain on a task until completion. We feel that less relevant to our fine-grained perspective of multitasking are the factors of Lack of Premeditation, which refers to the inability to carefully plan longer term action (e.g. before going on a trip to Hawaii); and sensation-seeking, the tendency to seek adventure.

H2a: *Impulsivity-urgency is related to shorter focus duration.*

H2b: *Impulsivity-(lack of) perseverance is related to shorter focus duration.*

Stress. Stress can also impact online focus duration. Lazarus [23] defines stress as when external and internal demands exceed a person's available resources. Theories of the effect of stress on attention explain that stress uses up available attentional resources [2]. Some amount of stress can prolong focus and inhibit attending to irrelevant information, or distractions [18]. However, alternative views (capacity-resource view; thought suppression) explain that stress makes it difficult for people to selectively focus since stress depletes resources that inhibit the ability to filter out distractions [1], and to suppress irrelevant information [33]. In laboratory studies, stress has been associated with impaired selective attentional performance, e.g. [32], which is consistent with views that stress depletes attentional resources. In the workplace, psychological stress has been linked to reduced efficiency, decreased performance capacity, and low motivation [10]. Thus, we expect stress to shorten focus.

H3: *Stress is related to shorter focus duration.*

Physical well-being: sleep. A consistent finding of sleep deprivation is that it affects psychomotor vigilance [14, 24], even when sleep loss is relatively minor [31]. Laboratory studies show that subjects who were sleep deprived showed deficits in switching between different cognitive tasks, yet no deficits were found with repetitive tasks [2]. This suggests that sleep loss impairs cognitive control which affects the ability to filter out irrelevant stimuli, i.e. to ignore distractions. Thus, less sleep could impair the ability to filter out distractions, leading to shorter focus duration. These results however, are all from laboratory studies. It is not clear whether these results on sleep duration would apply to people's behavior in the workplace. We expect that the effects of sleep duration would be manifest through shorter durations of focus when working online.

H4: Less sleep is associated with shorter focus duration.

Focus duration and productivity. What might be a consequence of focus duration? People who switch between different tasks take longer to finish them, as opposed to performing tasks in sequential order [13]. Multitasking is reported to contribute to cognitive overload [29], which could also negatively impact productivity. For instance, in a hospital setting, multitasking resulted in gaps in information flow and errors [22]. We expect that information workers who shift their online focus more frequently over the course of the day should feel less productive at the end of the day.

H5: *Shorter focus duration is related to lower assessed productivity at the end of the day.*

METHOD

Forty volunteers (20 females, 20 males) in a large high tech U.S. corporation, who responded to an ad, were observed *in situ* in their real work environment for about 12 business days. Their job roles involved information work and were varied: administrative support, engineering, and management. Participants were compensated with $250.

Participants' computer activity at work was logged during all business hours automatically via custom-built Windows Activity Logging software. This logging software tracks every open application, which window is in the foreground, and whether the user is interacting with that window (with mouse, keyboard, touch, etc.). We measured the total duration of all applications, defined as the number of seconds that each application was in the foreground window, ending when the user either changed windows or the computer had no keyboard or mouse activity for a period of five minutes. As participants at times might not be using their computer for various reasons (e.g., while at a meeting), we used only those hours of data when the computer was used (i.e., when logged data showed that computer duration was greater than zero for that hour).

Focus Duration (online) *was measured* by dividing total daily logged computer duration by the number of computer screen switches. As discussed, we take a fine-grained perspective on multitasking to view shifting attention online. We feel that screen switches are a reasonable proxy for attention duration with computer work.

At the beginning of the study, a general survey was given. *Neuroticism* was measured as part of the Big 5 personality inventory [26]. *Impulsivity* was measured by the UPPS Impulsive Behavior Scale [34], using the dimensions of Urgency and Perseverance. *Stress* was measured by the Perceived Stress Scale (PSS) [3], a widely-deployed global measure of the degree to which people perceive stress in their lives. While these scales could be related to a greater or lesser degree, we felt that a thorough examination of our hypothesized variables would tell a more complete story. Our goal was to discover several lines of converging evidence that particular factors were significantly at play.

Productivity was measured by six items in the daily end of day survey, asking about accomplishment, efficiency, satisfaction, effectiveness, quality, and overall productivity (e.g., *"How efficient do you feel you were today in performing your work?").* Responses were measured on a Likert scale, with 1=not at all, and 7=extremely. The item dimensions were highly correlated (with correlations ranging from .68 to .94), so we combined them additively to construct an index measure of Productivity.

Sleep was measured by the Fitbit Flex actigraph which participants wore 24 hours a day.

Analyses. Focus Duration was our dependent variable for H1-H4. For H5, Focus Duration was the independent variable and end-of-day Productivity assessment was the dependent variable. For the analyses of daily data, we used only full weekday days of window logging (the time of the study setup sometimes resulted in partial days of data collection), and used only days when computer usage was greater than zero. For analyzing Neuroticism, Impulsivity, and Stress, we analyzed the data using regression analysis in SPSS. For analyzing sleep and productivity, which were daily data, i.e., multiple daily measures per person, we used Linear Mixed Models (**LMM**) in SPSS. This uses random and fixed effects to account for the repeated measures within subjects.

	Mean	sd	Median	%Total
All computer usage	47.0	21.4	40.2	100%
Email usage	61.8	35.1	51.8	33.95
Productivity SW usage	64.0	39.3	52.9	21.14
Communication SW usage	42.5	25.5	34.5	5.96
Daily switches within apps	131.9	103.7	112.0	--
Daily switches betw apps	272.7	117.9	261.0	--

Table 1. Avg. online screen focus duration (sec.) and switches.

RESULTS

Table 1 presents the average duration of focus on any computer screen for our 40 participants. Averaged over all workdays per person, and for all applications and online sites, the median duration of focus is about 40 seconds. Participants had slightly longer focus on email clients, and productivity software (Word, Powerpoint, Excel, Visual Studio, etc.) but had a shorter focus when using communication software (e.g., Skype, IM, Lync). The SD is also fairly small. In Table 1 we further divide switching behavior into switching between applications (e.g., between Word and email) and switching within applications (e.g., opening up different word documents or switching Internet sites). Switches occur more often between different applications which could suggest more of a context shift than switching within applications. Thus, the data shows that our participants' online activity is characterized by fairly short durations of focus on their computer screens.

Personality traits and focus

Results of our hypotheses tests are shown in Table 2 with p-values adjusted by the Holm-Bonferroni sequential adjustment [16]. The results support H1: the higher the Neuroticism, the shorter the focus duration, explaining 13.4% of the variance of online focus duration.

We found support for H2a: the trait of Impulsivity-Urgency is associated with shorter focus duration, explaining 16.5% of the variance. We reject H2b: Impulsivity-Lack of Perseverance was not significantly associated with focus.

Stress and focus

We found weak support for H4: a strong trend showed that higher Stress was related to shorter focus duration, explaining 10.5% of the variance.

Sleep and focus

Eight outliers were removed from the daily sleep variable. For this two week study, we found a strong trend that the less one sleeps, the longer is the focus duration. Thus, we reject H4. However, this surprising result could be explained by deadlines. In the workplace, when people have deadlines, they may sleep less the night before and become highly focused on work to meet the deadline. Participants

	F	Df	p*	coeff	adj R^2
H1: Neuroticism	7.01	1, 39	.04	-1.69	13.4
H2a: Impuls-Urgency	8.68	1, 39	.03	12.16	16.5
H2b: Impul-Lack Persev	.26	1, 39	.62	-2.97	0
H3: Stress	5.56	1, 39	.06	-1.55	10.5
H4: Sleep	5.60	1, 281	.06	-.12	1.5
H5: Productivity regressed on focus duration	4.16	1, 232	.04	.01	4.7[1]

Table 2. Results of H1-H5 examining Focus Duration. *p-values are adjusted with the Holm-Bonferroni method [16].

were asked at the end of the day how much deadlines influenced their work that day with a 7-point Likert scale item. We found that the more deadlines influenced work, the longer the focus duration: $F(1,285)=4.32$, $p<.04$. A significant sleep by deadline interaction shows that the combination of less sleep with more influence of deadlines, the longer the focus: $F(1,289)=3.74$, $p<.05$. However, we are unable to draw conclusions on how sustainable this would be over a longer period of time as our two-week study duration limited us from investigating that question.

Productivity and focus

Using the daily data, three outliers were removed from focus duration. Productivity assessment was the dependent variable, and Focus Duration was the independent variable, controlling for Neuroticism, Impulsivity-Urgency, Stress, and Sleep. We found a significant relationship, supporting H5. The Variance Inflation Factor was less than 5, indicating that multicollinearity was not a problem.

Factor analysis

We used factor analysis on our observed variables (including deadlines) to uncover a structure of "unobserved variables" [21]. With factor analysis, each variable is primarily associated with a distinct factor. We used a Varimax rotation with a Kaiser normalization. A scree plot revealed that two factors should be used, accounting for 62.4% of the variance (Table 3). We interpret the first factor as "lack of control" since Neuroticism and Stress may be responsible for a lack of control in suppressing thoughts (e.g. in reanalyzing prior events) and Impulsivity-Urgency refers to a lack of impulse control. The second factor loaded onto the single variable of deadlines, which we interpret as "time pressure", i.e., a situational explanation. We next regressed Focus Duration on these two factors: $F(2, 39)=5.51$, $p<.008$, adj. $R^2=18.8$. The results show that lack of control is a significant factor that can explain online attention duration (Table 3).

[1] As there is no standard method for determining an R^2 in LMM models [7] we ran a linear model with fixed effects alone to get an R^2 value. Not including random effects will underestimate the variance explained but we feel it is a reasonable estimate.

Factors	t	p*	coeff
Lack of Control (Neur, Imp-Urgency, Stress)	3.23	.003	-9.98
Time Pressure (Deadlines)	.77	.45	-2.37

Table 3. Factor analysis results of variables that loaded onto two factors, and regression analysis results with Focus Duration as dependent variable.

DISCUSSION AND CONCLUSIONS

We found that in information work, online focus is characterized by short durations, with only a median span of 40 seconds. Our results build on previous *in situ* descriptive studies of multitasking [5, 15] by suggesting that there may be an inherent trait of distractibility, cf [11], uncovered by a factor we call lack of control. As personality is difficult to change, the factor of "lack of control" could represent an invariant trait that makes people susceptible to online distractions. Given all the potential distractions that digital media presents to information workers, our results suggest that inherent traits could make some people more *susceptible* to distractions.

A potential consequence of multitasking is that shorter focus duration positively correlates with lower assessed productivity at days' end. This is consistent with interviews that describe that switching activities has a cost, e.g., in doing redundant work [15]. The result provides empirical support for costs in information work though more research is needed to uncover potential underlying factors.

Our results of personality effects have implications for educational systems and game design, where personality is found to influence use, e.g. [28]. System design could adapt to a user depending on one's pattern for focusing attention. Also, virtual agents could adapt interruptions and messaging according to a person's ability to focus.

As our study was only done in one workplace, we can only generalize to similar workplaces that are high tech, with educated workers (like our participants). Because personality traits are assumed invariant, the relationship of personality and focus duration appears causal (i.e., it is not likely that one's focus duration changes one's Neuroticism or Impulsivity trait). However, there could be underlying variables that influence these relationships which all warrant further exploration. Nevertheless, this research is a first step at investigating individual differences that can influence online focus; we hope that this research can spark further investigation to unpack explanations for multitasking and attention focus in the workplace.

ACKNOWLEDGMENTS

This material is based upon work supported by the NSF under grant #1218705.

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