

Impact of Interruptions on White Collar Workers

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Abstract: An interruption is a randomly occurring, discrete event that breaks the continuity of cognitive focus on a primary task and typically requires immediate attention and demands action. This article investigates the effect of the timing of an interruption and source on both demanding and non-demanding tasks. Time logs of daily work activities from 21 white collar workers were analyzed. The findings show that interruptions have a negative impact on worker performance when they occur at the middle or end of the current/primary task. In addition, results show that the majority of the interruptions were externally generated (78%) rather than internally generated. The more demanding the tasks that were interrupted, the greater the negative impact on the overall performance. Suggestions for reducing the impact of interruptions are also discussed.

Keywords: White Collar Workers, Internal and External Interruptions, Multitasking, Knowledge Workers

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As economic and global pressures increase, more companies are laying-off employees and/or restructuring jobs in an effort to cut costs and increase profits. This has increased the workload of white collar workers (managers, professionals, etc.). In office environments there are also growing technological demands, resulting in workers doing more with less, managing multiple activities simultaneously, and attempting to multitask (Huehn-Brown & Murray, 2010; Weiss & Adams, 2011). A variety of tools and technologies can be useful in improving productivity and the capacity to multitask, but at the same time these tools can cause interruptions that prevent workers from concentrating on their task and affect the quality of work (Knight & Westbrook, 1999; Bailey, Konstan, & Carlis, 2001; Hudson, Christensen, Kellogg, & Erickson, 2002).

An interruption is “an externally generated, randomly occurring, discrete event that breaks continuity of cognitive focuses on a primary task” and typically “requires immediate attention” and “insists on action” (Corragio, 1990). White collar interruptions are those that affect the employees performing mentally tasking work, often called knowledge work. According to Spira and Feintuch (2005), U.S. office workers are interrupted on the job as often as 11 times an hour (González, 2005), costing as much as \$588 billion to U.S. businesses each year. These data show the significant economic impact of knowledge worker interruptions and distractions. Kotnour, Matkovich, and Ellison (1999) noted the important work of creating, assimilating, disseminating and applying knowledge done by this classification of workers.

White collar workers are faced with interruptions by the very tools and technologies designed to allow multitasking and increase productivity. Other common forms of interruption

include colleagues and self-interruption. Self-interruption is when the individual performing the work is the source of his or her own interruption – suddenly remembering the need to call or email someone and acting on this is an example of this type of interruption. Previous work in the field of interruptions focused mainly on the effects of interruptions on workers’ performance and how interruptions can be minimized. The focus has been mostly on the interruptions caused by use of technology and tools like emails, instant messaging, and phone calls; however, in this study we found that interruptions caused by other individuals and self-interruptions are a major portion of interruptions faced by white collar workers. This article considers these two types of interruptions in addition to other commonly researched interruptions while analyzing their impact on the performance of white collar workers. This article also analyzes the source of interruption (i.e., externally or internally generated) and its impact on overall performance of white collar workers. In addition, this study investigates the impact of interruptions on demanding and non-demanding tasks.

Related Work

Most previous work related to interruptions suggests that most interruptions have a negative effect on workers’ performance (Burmistrov & Leonova, 1997; Perlow, 1999). Interruptions cause significant time loss especially in white collar working environments. It not only decreases performance and efficiency but also causes stress and additional mental workload. Although interruptions usually have negative effects, some studies suggest that interruptions can sometimes also have a positive effect (O’Connell & Frohlich, 1995). These studies suggest that interruptions can give a much needed break from monotonous tasks and allow the worker to start again fresh (Speier, Valacich, & Vessey, 1999; Speier, Vessey, & Valacich, 2003).

Research has also been done on the forms and types of interruptions affecting white collar workers. Most common forms of interruptions affecting white collar workers are emails, instant messaging, telephone calls, and interruption by other persons/colleagues (Shamsi & Horvitz, 2007). Researchers have also investigated how to minimize the effects of interruptions and have suggested various tools to control interruptions. Some suggest delaying the receipt of information to avoid interruptions (Horvitz, Apacible, & Subramani, 2005). Providing external cues is also another way of dealing with interruptions (Altmann & Trafton, 2004).

Research Study

This study analyzes the effect of interruptions on white collar workers. Although many studies have been done on interruptions’ effects on white collar workers’ performance, most of these studies have been done in artificial settings (Adamczyk & Bailey, 2004; Eyrolle & Cellier, 2000; Schiffman & Greist-Bousquet, 1992; Cutrell, Czerwinski, & Horvitz, 2001). A true office setting

cannot be created in a lab. In the lab setting the researcher controls the interruptions, their occurrences, and timings, which may not accurately depict how interruptions actually occur. Some studies have been done in a natural setting by using shadowing and observational techniques (González & Gloria; 2005); in these studies the researcher analyzes the interruptions based on his or her observations. While shadowing and observation are effective methods for empirical study, they come with disadvantages. They are expensive, labor-intensive, and difficult as well as time consuming (Holmes & Bloxham, 2007). The presence of an observer may also affect the knowledge worker, and it may make the person uncomfortable and/or change the worker's behavior. Also, not all participants are willing to share details of their work, especially due to confidentiality issues.

In this study, the workers themselves maintained a log of daily activities and interruptions. This research also analyzed the source of interruptions to investigate the percentage of interruptions generated externally and internally. Externally generated interruptions are those generated by external sources, such as a colleague, phone call, or text message. Internally generated interruptions are those generated by workers themselves. An example of an internally generated interruption is when a worker remembers something important to do in the middle of another task. The effects of interruptions on demanding and non-demanding tasks (as defined by the worker) were also studied.

Additionally, this study analyzed the effect of the timing of an interruption on worker performance. Some researchers have suggested that interruptions are least harmful when they occur in the early stages of the primary task (Czerwinski, Cutrell, & Horvitz, 2000), while others suggest the opposite – that interrupting a worker in early stages of tasks is harmful (Cutrell, Czerwinski, & Horvitz, 2004; Gievska & Sibert, 2005). Some researchers have also

suggested that interruptions are harmful when a worker is in the middle of the task (Bailey, Konstan, & Carlis, 2000).

Methodology

Surveys and time logs were used to collect information from participants. Consent forms were used and the research project received institutional review board (IRB) approval from the university. A letter explaining the research, how to complete the time log, and a sample time log were provided in the written materials given to participants. Initially, participants were asked to maintain a time log for two days. A preliminary review from initial subjects showed that the data of the second day did not add significantly new information. It also proved to be a barrier to participation. Thus the majority of participants kept the log for only one day. Only the first day was considered for those participants who provided multiple days of time logs.

The survey consisted of two sections: (1) general background information about the worker, and (2) questions regarding interruption occurrences and impact on work. Participants completed the survey before starting the time log to assess their awareness of interruptions and their effects. A time log of daily activities was used to collect data about interruptions. The participants maintained a time log of daily activities for one complete day. The time log is a form with rows to list tasks as they occur and columns for information about the tasks, including start time, difficulty level (demanding or non-demanding), and whether or not a task is an interruption. Additional columns were used to record information about interrupting activities, including types (*audio, visual, person* or *other*), the timing of the interruption (*start, middle* or *near the end* of the task), and the interruption's effect (*positive, slightly positive, slightly negative, negative, or no effect*). Exhibit 1 provides an example time log entries.

Exhibit 1. Sample Completed Time Log

Task #	Time	Current Task	Demanding	Interruption	Type	Source	Timing	Effect
6	11:30 AM	Lunch	Not D	No				
7	12:00 PM	Write report	D	Yes	O	I	M	P
8	12:40 PM	Prepare presentation	D	Yes	O	I	M	P
9	1:00 PM	Move furniture/ supplies to new location	Not D	Yes	P	E	M	NO
10	2:00 PM	Respond to emails	D	No				
11	2:17 PM	Phone call	Not D	Yes	A	E	E	SN
12	2:36 PM	Return to emails	D	No				
13	2:45 PM	Walk to other building	Not D	No				
14	3:00 PM	Give presentation	D	No				
15	4:10 PM	Return to office	Not D	No				
16	4:20 PM	Prepare for next day	Not D	No				

Legend

Type A = Audio, V = Visual, P = Person, O = Other

Source I = Internal, E = External

Timing S = Start, M = Middle, E = End

Effect P = Positive, SP = Slightly Positive, SN = Slightly Negative, N = Negative, NO = No Effect

Results

There were 21 subjects in the study – 11 males and 10 females. They ranged in age from 25-54 years old and worked in the United States (14 participants) and India (7 participants). A total of 145 interruptions were reported – an average of seven interruptions per individual per day. Previous research has shown that an average U.S. office worker faces around 11 interruptions per hour (Spira & Feintuch, 2005). This number includes brief interruptions such as a coworker asking about lunch plans. We suspect fewer, longer interruptions were reported in this study due to the time and effort required to report them in the detailed time log of daily activities, resulting in a tendency to not record very brief interruptions. Also, differences were noted in the logs – some time logs gave a good and detailed overview of daily tasks and interruptions while some logs had fewer entries. Exhibit 2 lists the number of tasks and interruptions faced by each participant.

The timing of interruptions varied. The majority of interruptions (more than 51%) occurred while the worker was in the middle of the primary task. Nearly 27% of interruptions occurred at the beginning of the primary task, while nearly 22% were reported occurring at the end of primary task. Information on timing was collected to determine if the impact was different for the different phase (initiating, working, or completing a task). A summary of the effect of interruptions organized by timing is provided in Exhibit 3. Most participants reported that interruptions were not that harmful when they occurred at the beginning of the task. The reason may be that users find it easy to switch attention between tasks easily as they have just begun with the task. This result is consistent with previous research

suggesting that interruptions are least harmful at the beginning of a primary task (Czerwinski, Cutrell, & Horvitz, 2000).

An Analysis of Variance (ANOVA) was performed on work interrupted early in the task. As the p-value = 0.006, we concluded that the result “no effect” is significantly different than the positive or negative response. Interruptions at the beginning of a primary task have little or no effect on worker performance. A possible explanation for this is that white collar workers can easily switch their attention early in the task, before the user has become deeply engaged in the task goal. Interruptions occurring at the middle of the primary task tend to have a slightly negative effect on the performance. It may be difficult for a white collar worker to get interrupted in the middle of a task and then resume the primary task. This result is in line with previous research, which suggests interruptions are most harmful when a worker is in the middle of a task (Bailey & Carlis, 2000). We conducted an ANOVA to analyze the effect of interruption during the middle of a primary task. During this analysis, “slightly positive” and “positive” were combined, as were “negative” and “slightly negative”. With a p-value 0.011, we reject the null hypothesis and concluded that interruptions occurring at the middle of a primary task are reported to have a negative impact on the overall performance.

Interruptions occurring at the end of the primary task tended to have a strong negative effect on the worker's performance. This result supports previous research that an interruption at the end of a task led to longer resumption times, partially because of the effort to decide on what to do next, but moreover because of the existing relationships between subsequent subtasks (Gievska & Sibert, 2005). No participant thought that interruptions

Exhibit 2. Number of Tasks and Interruptions

Subject No.	Total Number of Tasks	Total Number of Interruptions	Number of Non-Demanding (ND) Tasks (%)	Non-Demanding Tasks Interrupted	Number of Demanding (D) Tasks (%)	Demanding Tasks Interrupted
1	19	9	13 (68%)	4	6 (32%)	5
2	16	9	13 (81%)	8	3 (19%)	1
3	24	9	16 (67%)	7	8 (33%)	2
4	29	9	26 (90%)	8	3 (10%)	1
5	15	9	11 (73%)	7	4 (27%)	2
6	20	8	12 (60%)	2	8 (40%)	6
7	19	8	11 (58%)	4	8 (42%)	4
8	25	10	9 (36%)	1	16 (64%)	9
9	19	5	6 (32%)	2	13 (68%)	3
10	22	8	2 (9%)	0	20 (91%)	8
11	21	7	6 (29%)	1	15 (71%)	6
12	20	6	8 (40%)	2	12 (60%)	4
13	21	7	7 (33%)	2	14 (67%)	5
14	22	7	8 (36%)	3	14 (64%)	4
15	19	6	3 (16%)	0	16 (84%)	6
16	20	4	3 (15%)	1	17 (85%)	3
17	19	6	7 (37%)	3	12 (63%)	2
18	19	5	4 (21%)	1	15 (79%)	4
19	18	6	4 (22%)	0	14 (78%)	6
20	18	3	3 (17%)	0	15 (83%)	3
21	17	4	2 (12%)	0	15 (88%)	4

Exhibit 3. Effect of Interruptions Based on Timing

Beginning	S Pos (%)	Pos (%)	No (%)	Neg (%)	S Neg (%)	Total
	1 (3%)	4 (10%)	24 (62%)	4 (10%)	6 (15%)	39
Middle	S Pos (%)	Pos (%)	No (%)	Neg (%)	S Neg (%)	Total
	11 (15%)	5 (1%)	18 (24%)	7 (10%)	34 (46%)	75
End	S Pos (%)	Pos (%)	No (%)	Neg (%)	S Neg (%)	Total
	5 (16%)	0 (0%)	4 (14%)	13 (42%)	9 (29%)	31

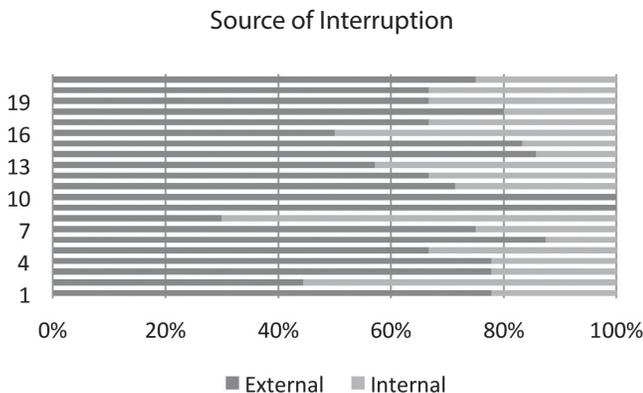
occurring at the end had a positive effect on their performance. We conducted an ANOVA to analyze the effect of interruption at the end of a primary task. During this analysis “slightly positive” and “positive” were combined, as were “negative” and “slightly negative”. With a p-value 0.011, we reject the null hypothesis and concluded the overall effect is negative when interruptions occur at the end of primary task.

Most of the interruptions reported were from an external source – only 22% of interruptions initiated from an internal source (such as remembering to call a colleague). This did vary for the individual as can be seen in Exhibit 4. A review of the time logs showed “making phone calls” and “visits to others” were the major types of internal interruptions (together comprising nearly 50% of the internal interruptions). Managing these internally generated interruptions can reduce their effect. Other types of interruptions were email and instant messaging as seen in Exhibit 5. It was noted that a few of the participants were never interrupted by telephone calls. When investigated, we found that two participants had secretaries to answer their calls, so were not interrupted by phone calls, and three additional participants worked in an environment where they were not affected by phone calls. Our results show that when interrupted externally, the performance of the person was reportedly effected 65% of the time and the effect was positive for less than 6% of external interruptions.

Demanding vs. Non-Demanding Tasks

The participants reported being disrupted during approximately a third of their work tasks. A review of the original tasks that were interrupted showed that almost 40.6% of non-demanding tasks

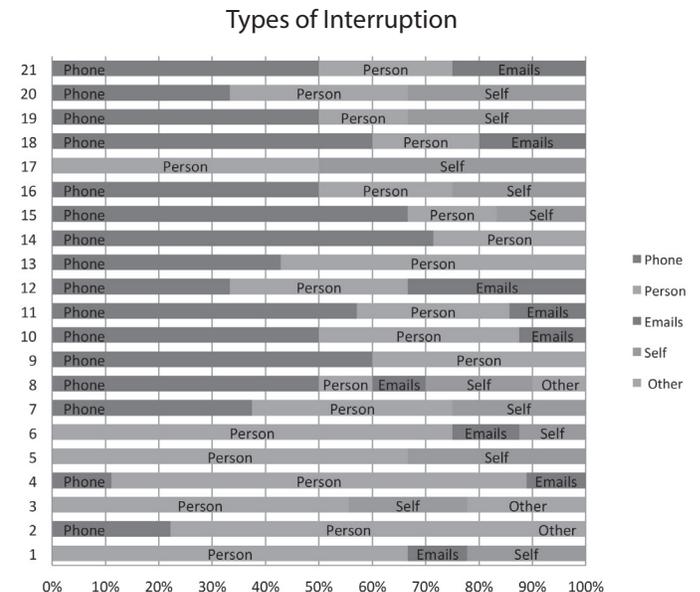
Exhibit 4. Source of Interruption



were interrupted, and 59.4% of demanding tasks were interrupted. This is the opposite of what would be preferred. A positive effect of interruptions has been associated with trivial, mundane tasks. Demanding tasks have a greater resumption lag and are harder for the worker to remember *Where was I?* and *What was I doing?* Our study bore this out – only four interruptions (1.6%) of demanding tasks had some reported positive effect. More than 60% of interruptions had a negative impact on demanding tasks, and just fewer than 40% were rated as no impact.

The pre-time log survey indicated that many of the white collar workers did not consider interruptions as having a negative impact on their performance. Fifty-two percent of participants predicted that interruptions might have some negative impact on performance. The remaining felt interruptions might affect their performance positively or have no effect. When participants were asked if interruptions were a significant issue to them, 11 (52%) of the participants said interruptions did not affect their performance and were not a significant issue. They considered interruptions as a part of their job, expected interruptions, and said they were prepared for interruptions. Workers who assumed interruptions were not a significant issue recorded interruptions as having a negative effect when they actually occurred. Based on the time logs 50.3% of interruptions had a negative effect, 31.7% had no effect, and 17.9% had a positive effect.

Exhibit 5. Interruptions by Type for Each Subject



Limitations

As with all studies using human subjects, there are limitations to this study. Twenty-one individuals participated in the study from various organizations and two countries; all were in professional or managerial positions. Participants were diverse with respect to gender, age, work experience, and work specifics. Variation in participants was sought in an attempt to make the results generalizable, but without further studies verifying these results, there is no certainty that the findings are generalizable. The data were self-reported and could have been affected by bias resulting in over reporting (i.e., "I want them to think I am busy") or under reporting (i.e., "That was so short, I won't write it down in the log") or uncertainty (i.e., "How do I classify that interruption"). With this method the danger of a subject forgetting to report events was also a concern.

Participants received written instructions and an example time log in an attempt to minimize this issue. The study focused on longer interruptions, so some very short interruptions may not have been captured. Internal, self-generated interruptions were included in this study, which provided additional insight when compared to previous studies; however, capturing this data depended on the participants realizing they had interrupted themselves to work on a new task.

Implications for Engineering Managers

In a perfect world, interruptions could be eliminated, or at least scheduled, at a more convenient time. In the real world, engineering managers face the unwelcome fact that interruptions are a common occurrence. Since interruptions typically cannot be avoided, it is important for today's manager, in the ever increasing hectic workplace, to minimize the impact of interruptions and to manage the workday. Our study of white collar interruptions showed that the type of task that is interrupted and the point during the task at which the interruption occurs influences performance. Our findings suggest that interruptions are more harmful if they occur later in the primary task, which supports previous research findings. For example, if a design engineer is studying a difficult blueprint and is in the middle or end of this task when a colleague knocks on the door, the impact of that interruption will be negative. The white collar worker will have to go over the blueprint again from the start to understand the task at hand. This interruption effect for the white collar worker is negative. Our study also suggests that interruptions occurring at the beginning of the task tend to have no effect on the white collar worker. Using the same example, if the design engineer has just opened the blueprint and started reading it when his or her phone rings, it will be easy to return to the primary task of reviewing the blueprint. Based on this result, a recommendation for white collar workers is that when interruptions occur in the later portion of the primary task, it is best to delay or ignore the interruption to minimize the negative effect. This can be done by diverting a phone call to voicemail or asking a colleague if you can come to their office once the current task is finished.

Conclusions

Results from this study also support previous findings that interruptions affecting demanding or mentally challenging tasks tend to have a negative impact on the performance of white collar workers. Contrary to the opinion of some, including many study participants, when a non-demanding task is interrupted, it still negatively affects the performance of the worker. This is

significant to engineering managers – interruptions have a cost even if the task at hand is not overly demanding. All interruptions should be minimized and managed as much as possible.

Our study showed that the majority of interruptions (79%) had an external source. The type of interruption varied for different individuals; for example, some individuals had significant interruptions from phone calls and emails, while others did not. Previous researchers have suggested that internal interruptions provide relief from boredom and/or improve job satisfaction. The self-reported time logs from this study suggested that the more common reason was remembering some important task or phone call that needed to be made. Another finding from the study is that most white collar workers were not aware of the negative effects of interruptions. Only after completing the time log were the negative effects of interruptions understood; therefore, another way of reducing the impact of interruptions is to create awareness about their negative effects, to seek processes that reduce them, and to better manage interruptions when they occur.

Areas for Further Research

As with all studies, this research can be repeated to improve its validity. It could be modified to explore whether or not differences in individuals' personalities (i.e., introvert vs. extrovert) make a difference in reactions to interruptions. Age and experience could also be explored as predictive factors in how well individuals respond to interruptions. Are younger workers better at switch-tasking and dealing frequency interruptions? Are more experienced workers better at juggling multiple task and lines of thought? Potential interventions to deal with interruptions could also be studied to verify their potential benefits on worker performance.

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