Tracking Technostress: A Task Interruption of Data Entry Study

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Abstract. The prevalence of information systems and the resulting increase in continuous notifications have blurred the lines of work and leisure, resulting in increased stress. These changes in the work environment have had detrimental effects on workers ability to sustain attention and remain productive. Despite academic interest in both IT-mediated interruptions and technostress, there has been little research on the juncture of both of these while also utilizing eye tracking. We propose an experimental design on a sampling of undergraduate students in order to study the relationship of IT-mediated interruptions on task performance and the moderating effect of technostress on this relationship. In addition to we will utilize eyetracking (pupillary dilation and gaze duration) to tie the level of IT-mediated interruptions to cognitive resources in low and high technostress individuals.

Keywords: Technostress · Interruptions · Eye tracking · NeuroIS

1 Introduction

Technology has increasingly infringed on the distinction between work and leisure with concepts such as bring your own device (BYOD) and telecommuting [1, 2]. Personal phones with work email, work social media accounts, and work collaborative software are increasingly prevalent in our society. The convenience and availability of work has changed our work-life balance in favor of work. These devices have led to increased interruptions throughout an individual's day which leads to family-to-work conflict [3]. Meanwhile, individuals react to technology in different ways, with some embracing new technologies and others reticent of adoption. Technostress, stress caused by or impacted by technology, is a measure of an individual's ability to cope with technology [4]. Individual responses to coping with technology has further changed the nature of work [5]. Taken together, individual technostress and increasing IT-mediated interruptions may interact, creating a compounding negative effect on work performance.

In fact, a recent call for research in the area of technostress suggested more empirical explanation is needed on indirect variables, as well as, any mediating effects on how technostress is formed [6]. The specific empirical explanations of how and why

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technology creates stress is still being identified [6]. However, technostress has been linked to decreased job satisfaction and job performance [7]. This study aims to show how technostress is itself a mediator of specific task performance.

One such intervening variable could be the increased interruptions imputed by technology and the shift in attention that interruptions require, which increases cognitive load [8]. Interruptions have been shown to increase an individual's workload when they are interrupted mid-workflow [9]. Research has shown perceived IT-mediated interruptions to be inversely related to perceived task accomplishment, meaning the more one feels they are interrupted the less they feel they accomplish [10]. These two studies show that interruptions increase perceived workload while decreasing perceived task accomplishment, but empirical evidence connecting these findings to diminished task performance is limited.

While both technostress and IT-mediated interruptions are linked to lower task performance, scant research exists examining the interaction of these increased interruptions and technostress on work performance. In this study, we examine a potential moderating role of technostress on IT-mediated interruptions and task performance. In this study, we aim to address the following research questions:

1. Do IT-mediated interruptions impact task performance?
2. Does technostress play a moderating role in relationship between IT-mediated interruptions and task performance?
3. How do IT-mediated interruptions of varying complexity affect the attention and cognitive load of individuals working on a task?

The remainder of the paper proceeds as follows. First, we review the theoretical foundation and research surrounding IT-mediated interruptions, technostress, and neuro information systems (NeuroIS). Next, we propose a study to elucidate the relationship between IT-mediated interruptions, technostress, and task performance. Using insights from eyetracking, we propose tying the findings to overall cognitive load and attentional resources. The findings will contribute to the literature in two primary ways. First, we hope to establish the moderating role of technostress in IT-mediated interruptions and work performance. Second, the study will provide insights into the extent to which IT-mediated interruptions disrupt the work process, potentially leading to poor task performance.

2 Theoretical Background

2.1 IT-Mediated Interruptions

IT-mediated interruptions (i.e., interruptions caused by technology) have been found to occur frequently in the workplace, costing managers up to ten minutes of work per hour and creating about 70 suspensions of work per day for office workers [11]. Knowledge workers are particularly susceptible to IT-mediated interruptions, which can last up to 30 min and, in some cases, the individual may never come back to the task once interrupted [12]. IT-mediated interruptions can be problematic outside of work as well.

For example, in a study of after-hours work related IT-mediated interruptions resulted in impacts to both work and home, causing exhaustion and decreased performance [2].

Not all interruptions are the same, some represent a minor distraction while others can completely derail a task. These interruptions require varying amounts of cognitive resources to resolve. A distraction, for example, only briefly interferes with one's task but is easy to come back like signing a paper or answering a question. A total interruption results in a complete break from the primary activity and a shift in mindset, such as meeting with one's supervisor or attending to a new patient [12]. In interruption studies, one found physician's that are interrupted results in an increase in errors for prescriptions and laboratory tests [13], while another showed interruptions of complex decision-making tasks took longer and were less accurate [14]. However, interruptions are not always detrimental to task performance. If an interruption is relevant to the primary task it may in fact improve the task performance [15, 16].

The level of IT-mediated interruption influences how quickly one returns and becomes re-immersed in their primary task. The delay in returning to the primary task is referred to as the switching cost caused by the interruption [17]. In a study of radiologists, a telephone call interruption asking for an urgent parallel image diagnosis led to an increased time on the original task versus the control tasks, but not a decrease in accuracy of diagnosis [18], or more time to complete, but no change in outcome. Last, in another study on IT-mediated interruptions and a creative output task, those that were interrupted with a demanding task (i.e., a task requiring more cognitive resources) performed significantly worse on the primary task when compared to those with a lower-level interruption (i.e., a task requiring less cognitive resources) [19]. So, it shows that both the primary task and the interrupting task have various effects on task performance. The switching cost for more complex interruptions is higher and are proposed to be more harmful to overall task-performance. Therefore, we hypothesize:

H1: The complexity of the IT-mediated interruption is related to overall task performance, such that complex interruptions worsen task performance more greatly than less complex interruptions.

2.2 Technostress

Stress is a complex physiological response to the environment that includes increased affective arousal and is generally associated with negative emotional valence [20]. Technostress is the stress put upon workers while utilizing Information Communication Technologies (ICT) [21]. There are 5 dimensions to technostress: techno-uncertainty, techno-overload, techno-complexity, techno-invasion, and techno-insecurity. Techno-uncertainty is the stress caused by technology changes in an organization. The more changes of workflows, systems, logons, and software add to the stress of an individual. Techno-overload is the stress from too many information channels incurred by utilizing a variety of ICTs. Most have experienced this with notifications from different social media sites, game notifications, text messages, and laptop emails all while attempting to handle all simultaneously. Techno-complexity is the stress caused by one's ability to use and understand technologies to perform one's own job. Some systems are overly complex, do not have a great user interface and add stress and anxiety. Techno-invasion is the stress a technology can incur as it extends work into the home; taking time away from family, friends and leisure activities. Techno-insecurity is the stress caused by one's perception that not having technology skills may cause one to perform poorly or be fired [21].

In the foundational study of technostress, it was found that both gender (men) and age (younger) affect technostress at a higher rate [21]. Tarafdar et al. [7] found certain technostress was negatively correlated with individual productivity and role stress. In the follow-on study, Tarafdar et al. [22] found that technostress was also related to job dissatisfaction, role conflict, decreased innovation in the workplace, less job productivity, reduced commitment to an organization and dissatisfaction of IS. Another study found that compulsive usage of a smartphone also increased technostress [23].

Despite these linkages to task performance, little research has been done in the moderating and conditional effects that technostress is involved in [6]. This study proposes the relationship between IT-mediated interruptions, technostress, and task performance is more complex. We propose that technostress will moderate the relationship between IT-mediated interruptions on task performance similarly to how computer self-efficacy moderates techno-invasion on job anxiety [24]. Higher levels of technostress will exacerbate the effective of IT-mediated interruptions on task performance (Fig. 1).

Therefore, we hypothesize:

H2a: Technostress will moderate the influence of IT-mediated interruptions on task performance, such that higher level of technostress will strengthen the negative relationship of IT-mediated interruptions and task-performance

Furthermore, as the complexity of an interruption increases, we expect the moderation effect to increase, having a greater negative impact on task performance. Thus,

H2b: For complex IT-mediated interruptions, technostress will moderate the effect of IT-mediated interruptions on task performance, such that greater levels of technostress will worsen task performance when interruption complexity is high.

We further hypothesize that due to the nature of our interruptions inducing multiple streams of information that may impact technostress' techno-overload, techno-overload may itself directly influence task performance. The hypothesis stated another way is the less an individual perceives the technology is causing an overload the better the performance on the primary task.

H2c: Techno-overload will directly influence task performance, such that the higher techno-overload the lower the task-performance.

2.3 NeuroIS

NeuroIS uses the tools of cognitive neuroscience to investigate how the brain and body respond to information systems [25]. In the context of human-computer interaction, employing this set of methodologies can shed light on how individuals respond to changes in system design. NeuroIS studies have been used to understand locations of IS constructs

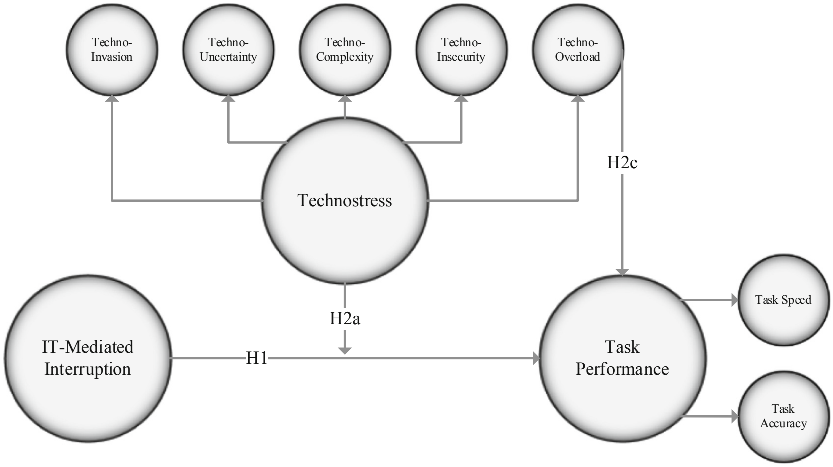

Fig. 1. Research framework of behavioral factors

[26], uncover bias in collaborative decision-making [27], and evaluating the effects of age on web design [28].

In this study, we use eye-tracking to help understand the effect of IT-mediated interruptions on cognitive resources. Previous studies have used gaze duration, pupillary dilation, and saccades to establish visual attention, increased cognitive load, and to record distraction [29].

In the radiologist study, eye tracking was utilized to see how interruptions affect the gaze of the radiologist. They found that immediately after an interruption more time was spent rereading prior dictation notes instead of going back to the radiological image [18]. In a study looking into interruptions and eye-tracking on reading, when individuals were interrupted by a 60 s audio story, they spent more time rereading previously read material and increases overall reading length [30]. Therefore, we hypothesize:

H3a: The post-interruption gaze duration will be positively related to higher complexity interruptions
H3b: Increased pupillary dilation, with a greater delay returning to baseline, will occur in higher-complexity interruptions.
H3c: Individuals with a high-level of technostress will experience greater disruptions in gaze duration and pupillary dilation when interrupted with a high-complexity interruption.

3 Method

The goal of this study is to understand how individuals respond to IT-mediated interruptions while conducting data entry and whether technostress plays a role. The unit of analysis will be the individual. Given this focus, we will set up a study in a controlled environment to avoid many external biases. We will utilize Rissler et al's framework on IT-mediated interruptions as a basis [31]. The boundary conditions will be the person, looking at demographics, traits, and abilities. The task-type being data entry, lower complexity, 6 min in duration, and 5 separate tasks. The manifestations of the IT-mediated interruption will have the initiator be the system initiator, actionable for 3 of the 4 interruptions, irrelevant to the primary task, visual (not auditory/tactile), with user actionable resumption. The manifestation of time will be present in the form of scheduled interruptions, without subject control of it occurring, frequency of 90 s, and duration being time to complete the interruption task. Lastly, utilizing the framework the consequences will manifest itself in task performance measured by speed and accuracy.

3.1 Participants

The participants will come from a student participant pool at a large research university in the United States who are currently enrolled in introduction courses in business and technology. We aim to collect data on 80 subjects in a within-subjects design. The participants will be consented and then randomly assigned to a treatment order.

3.2 Task

Our participants will be required to transcribe five patient encounter notes into a Qualtrics-based survey. The patient encounter notes follow a popular note taking method of evaluation called SOAP. SOAP breaks down a patient encounter into the Subjective assessment, Objective information, final Assessment, and Plan forward. Each participant will be randomized into a random ordering of the types of interruptions that will occur during the data input but will be the same across the 3 interruptions in that data entry. The interruptions will differ in anticipated cognitive load and interruption task (e.g. a low-level interruption would be basic demographic survey questions). Each data entry will be limited to 6 min total time, 90 s of task work followed by an interruption and return to task. In a pilot testing, the average input time for each encounter notes were 8 min and 42 s for the 1035 average character length of the input. One of the data entries will receive no interruptions in order to compare task performance to a control (Fig. 2).

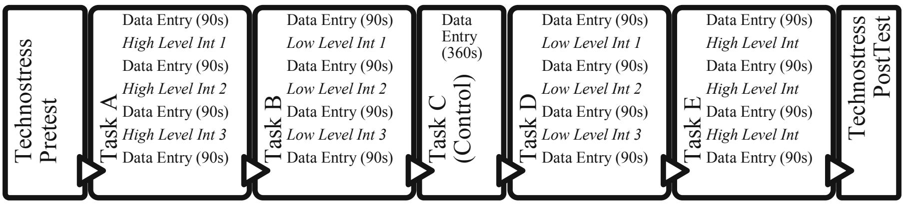

Fig. 2. Example experimental flow (Interruption categories will be counterbalanced between subjects to remove ordering bias)

3.3 Variables

There will be two treatments: high level of interruption, low level of interruption and a control treatment. There are two types of interruptions in each of the treatments. The treatments will be counter-balanced across participants to control for any task order effects.

Independent Variable. The independent variable in this study are the level of interruption and technostress.

The high cognitive interruption will be broken into two types of tasks. One will be a classification task, the second divergent thinking/creativity task. The classification interruption will be a requirement to classify 10 different animals into separate groups. For example, given animals {crocodile, sparrow, gecko, pigeon} and the participant must categorize them into either Bird or Reptile. Each of the interruption will include well-known animals and will not overlap with previous interruptions.

The divergent thinking cognitive interruption will utilize 3 common divergent thinking questions as shown in Table 1. These are adapted from both Guilford and Torrance Test of Creativity in a more recent study on the reliability validity of the measures [32]. The divergent thinking questions are meant to tap into creativity and have shown to have a higher alpha power change in nearly all areas of the brain over more simpler tasks [33]. The tasks will be timed for no more than 3 min but will not show the return to primary task button until after 2 min of the task.

Table 1. High interruption - divergent thinking questions

Divergent thinking	Question excerpt
Unusual Task – Interruption 1	For this task, you should write down all of the original and creative uses for a brick that you can think of
Instances Task – Interruption 2	For this task, you should write down all of the original and creative instances of things that are round that you can think of
Situations Task – Interruption 3	For this task, imagine that people no longer needed to sleep. What would happen as a consequence? Write down all of the original, creative consequences of people no longer needing to sleep

The low cognitive interruption will be a demographic survey and a non-relevant, passive interruption. The demographic survey will be separated into 3 instances of 2 questions in each instance (Table 2). This falls in line with other research utilizing quick information retrieval such as "Which country in the world has the largest number of people? [19].

The second low cognitive interruption will be non-relevant, passive interruptions. This falls in line with a call to research in IT-mediated interruptions regarding informational interruptions gaining little attention and identifying a unique aspect of our study [31]. These interruptions will take the form of a short fact that is interesting, but completely unrelated to the data entry. For example, "A Blue Whale is longer than 3 school busses lined up end to end (Blue Whale 30 m, School Bus 9.1 m)." Upon reading the fact, they can press a button to return to their primary task.

Table 2. Low interruption - demographic questions

Interruption #	Question excerpt
Interruption 1	What is your age?
	What is your gender?
Interruption 2	What is your current college Major?
	Which is your dominant hand?
Interruption 3	What is your primary spoken language?
	Are you Hispanic, Latino/a, or of Spanish Origin?
	What is your race? < select all that apply>

The IV Technostress and its five creators will utilize an adapted scale taken from Ragu-Nathan et al. as shown in Appendix A [21]. These measures need to be adapted slightly due to the inference of jobs in some of the measures. For example, in techno-insecurity a question is "I feel constant threat to my job security due to new technologies." By changing "job security" to "grades" it remains applicable to our student sample. We will conduct confirmatory factor analysis to ensure statistical similarity. The student's will be directed to consider all ICTs used for schoolwork as the context.

Dependent Variables. The dependent variables for this study are task performance and eye-tracking. Task performance will be measured by two factors, task accuracy and task speed.

Task accuracy will be measured using a mathematical concept called Levenshtein's Distance. This concept measures how many substitutions are needed from a given string (e.g. participant's data entry) and a reference string (e.g. original paper copy). The output of this is a ratio that is essentially a percentage and allows for comparisons amongst our sample in terms of task accuracy.

Task speed will be measured by taking the characters typed in the allotted time and dividing by either 6 min or the total completion should it be less.

In addition we will utilize the NASA Task Load Index (TLX) to measure the mental and temporal demands of the primary task, as well as, their perceived performance, effort and frustration [34].

Eye-tracking will be measured utilizing the Gazepoint GP3HD desktop eye-tracker and capture data to include eye gaze over time, heat map, percent of time on screen and pupillary dilation over time. Pupillary dilation will be used as a measure of cognitive load and gaze location and duration will be used to measure visual attention.

Controls and Manipulation Checks. In order to maintain control of our variables, we will control for age [35] as it has been found to be significant between older and younger populations. However, this affect will likely be nonexistent as the undergraduate population is rather similarly aged.

We will also control for technology experience, as that has also been found to impact technostress [36].

3.4 Procedures

Participants will complete the experimental procedure after being provided the informed consent approved by the university's Institutional Review board. The experiment will take place in a laboratory room set up for psycho-physiological analysis. The session will take no longer than 60 min.

Each participant will be provided with paper copies of the patient encounter SOAP notes, clearly labeled and in the order that will be presented to them. They will also be given an ergonomically efficient office chair for comfort and a standard keyboard and mouse for data entry. At this time, we will calibrate the eye tracking software. Should it not calibrate the first time, we will try a second time and if still not successful annotate the results in our laboratory log.

The participant will be shown the Qualtrics start page with their deidentified subject ID inputted. They will be instructed the data entry task has a set length and will be measured on both speed and accuracy. They will also be told that they must complete any task that may interrupt them. This should avoid questions to the experimenter when the survey automatically advances, which would further hinder the task performance and switching cost versus not being told about the interruptions.

Next the participant will conduct the data entry tasks, followed by the surveys. Upon completing both, they will receive a debriefing notice on screen in Qualtrics, as well as, a paper copy for their records and thanked for their time.

3.5 Data Cleaning and Analysis

Eye-tracking data will be separated into each task-interruption combination and compared Data will be aggregated across participants to elucidate average gaze duration on interruptions by treatment.

We will also calculate several other fields to include interruption time length calculated by subtracting the first click from the submission time. Repeated for all 12 interruptions. As well as, averaged for each type of interruption task (4 values), and perceived cognitive load (2 values). Task accuracy and task speed will be calculated as indicated above in section Dependent Variables. Technostress items will be averaged per sub item. Descriptive statistics will be drawn from the demographic survey.

The resulting cleaned data will be inputted into SPSS 25 for analysis utilizing ANCOVA.

4 Potential Implications

This study seeks to elucidate the relationship between, IT-mediated interruptions, technostress and task performance. In addition to identifying the moderating effect of technostress on IT-mediated interruptions and task performance. Lastly, tying the level of IT-mediated interruption to cognitive resources in low and high technostress individuals by utilizing eyetracking. This adds to the body of knowledge in regards to technostress by adding eye-tracking for data entry and IT-mediated interruptions on this specific task. In addition, this study may show how technostress is a moderator. Practice may find that these findings could help identify low performers by targeting technostress over the inevitable interruption, since studies have shown technical support provisions, technology involvement facilitations and innovation support are inhibitors of technostress [22]. The eyetracking data will provide insight into how the level of task interruptions effects overall cognitive and attentional resources, which will further elucidate the relationship between IT-mediated interruptions and technostress.

In our research there may be some way's forward to build a clearer model. This could include using different types of tasks, as there is evidence supporting interrupting a higher cognitive load task is harder to come back to. Another could be adding EEG data that could further isolate psycho-physiological data while conducting the experiment. Another could be to add other measures such as Computer Self-Efficacy or Computer Anxiety as additional factors that influence the task performance in a technology setting or adding burnout for a longer-term indication and impact.

Appendix A: Technostress Survey Items

Construct	Item
Techno-overload adopted from Ragu-Nathan et al. [21]	I am forced by this technology to work much faster
	I am forced by this technology to do more work than I can handle
	I am forced by this technology to work with very tight time schedules
	I am forced to change my work habits to adapt to new technologies
	I have a higher workload because of increased technology complexity
Techno-invasion adapted [21]	I spend less time with my family or friends due to this technology
	I have to be in touch with my school even during my breaks due to this technology
	I have to sacrifice my vacation and weekend time to keep current on new technologies
	I feel my personal life is being invaded by this technology
Techno-complexity adapted [21]	I do not know enough about this technology to handle my school-work satisfactorily
	I need a long time to understand and use new technologies.
	I do not find enough time to study and upgrade my technology skills

(*continued*)

(*continued*)

Construct	Item
	I find new students know more about computer technology than I do
	I often find it too complex for me to understand and use new technologies
Techno-insecurity adapted [21]	I feel constant threat to my grades due to new technologies
	I have to constantly update my skills to avoid failing
	I am threatened by classmates with newer technology skills
	I feel there is less sharing of knowledge among classmates for fear of failing
Techno-uncertainty adapted [21]	There are always new developments in the technologies we use at school
	There are constant changes in computer **software** in our organization
	There are constant changes in computer **hardware** in our organization
	There are frequent upgrades in computer **networks** in our organization

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