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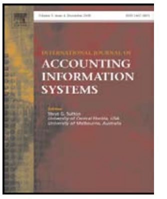

Investigating the effects of computer mediated interruptions: An analysis of task characteristics and interruption frequency on financial performance

K. Asli Basoglu [a,*], Mark A. Fuller [b], John T. Sweeney [c]

[a] *Washington State University, Department of Information Systems, PO Box 644743, Todd 442, Pullman, WA 99164, United States*
[b] *University of Massachusetts Amherst, Isenberg School of Management, 121 Presidents Drive, Amherst, MA 01003, United States*
[c] *Washington State University, Department of Accounting, PO Box 644729, Todd 242, Pullman, WA 99164, United States*

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Financial and accounting tasks require high levels of concentration as well as cognitive capacity. Today, advanced technology can help facilitate the effective and efficient completion of such tasks. At the same time, however, these same technologies can interrupt work flow and create work-related stress, thus having a deleterious effect on task performance. These interruptions can be characterized across a number of different dimensions, including frequency, complexity, duration, and relevance to the primary task, to name a few. This study examines the effects of interruption frequency, task complexity, and individual characteristics on cognitive load and subsequent decision-making performance on financial tasks. As hypothesized, the results indicate the significant influence of interruption frequency and order of task complexity on cognitive load which influences performance. This research has implications on the design and use of information systems by accounting professionals in order to reduce potential negative effects.

1. Introduction

Technology continues to change the nature of the work for many accountants and auditors. Software can be used to organize and analyze data employed in financial analysis, reduce the amount of tedious manual work associated with data management, enhance decision making, and improve access to important data sources. Technology also allows accountants and auditors to be more mobile and

* Corresponding author.
E-mail address: kab@wsu.edu (K.A. Basoglu).

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connected, exchanging information with clients as well as with their home office. However, these technologically enhanced work environments also create the opportunity for interruptions, in the form of phone calls, instant messages, e-mail notifications, task reminders, or incoming messages from clients. Even though existing research has shown that some interruptions may help improve performance (e.g. Yerkes and Dodson, 1908; Kahneman, 1973; Cohen, 1980), in other situations interruptions may also force accountants and auditors to multitask and shift attention from a primary financial task to another task (e.g., responding to an urgent e-mail message or a call on their Blackberry), resulting in decreased cognitive capacity and performance (Kahneman, 1973; Laird, Laird, and Fruehling, 1983; Woodhead, 1965; Speier et al., 1999).

Interruptions can vary on a variety of dimensions, including their frequency, duration, complexity, timing, or content (Speier et al., 2003). Possible consequences of interruptions include unsustainable mental attention and effort (Baecker et al., 1995), rationed resources (Baron, 1986), broken task flow (Bederson, 2004), impaired task processing (March, 1994) and task accuracy (Cellier and Eyrolle, 1992; Schuh, 1978), and increased time spent on task (Schiffman and Griest-Bousquet, 1992).

Although workers involved in financial and accounting tasks are exposed to interruptions, behavioral research in accounting has not yet systematically addressed how interruptions affect performance. To address this gap in the literature, we first review research on financial task performance and then hypothesize and test the effects of interruption frequency, cognitive load, and individual characteristics on decision outcomes. We then discuss the results of our research, and finally discuss the implications of this study for future research.

2. Prior research on financial task performance

Previous research on financial task performance has mostly concentrated on either task characteristics, such as complexity, or on individual characteristics, such as domain knowledge, gender, cognitive ability, cognitive fit, and information load. To examine this topic more thoroughly, we review existing research and identify gaps in this area of research.

The impact of task characteristics on performance has been analyzed by various researchers. Asare and McDaniel (1996) argue that when the underlying task is complex, the review process used to detect and correct any biases or errors in judgments and decisions made by inexperienced auditors has more steps, thus requiring more processing time on the part of the subject. Hence, they argue that task complexity is likely to increase time spent on set-up work as well as cognitive effort invested in the review task. Campbell and Illgen (1976) have shown a direct positive effect between task complexity and performance; however, Shapira (1989) has argued that this relation is moderated by various factors. For example, workers with low goal commitment had lower performance when the task was complex (Martin and Manning, 1995) or when they were under time pressure (Payne et al. (1993). Furthermore, Blocher et al. (1986) examined the effect of report format (graphic, tabular) and task complexity on the accuracy and bias of internal auditors' risk judgments and found a significant interaction between report format and task complexity for both decision accuracy (defined as ability to discriminate between high and low risk reports) and bias (defined as the propensity to report observing a high risk report).

Other researchers have analyzed the influence of individual characteristics on performance. For instance, O'Donnell et al. (2005) examined how procedural knowledge and outcome expectations interact with task complexity when tax professionals develop recommendations for clients. Their results suggest that outcome expectations about whether a position can be defended are positively associated with aggressive recommendations. As complexity increases, professionals with more procedural knowledge are shown to favor less aggressive recommendations and rely more heavily on their outcome expectations. Furthermore, while Duncan et al. (1989) and Newberry et al. (1993) argued that the domain knowledge that professionals develop through experience may make their decisions either more aggressive or more conservative (Cloyd, 1995; Helleloid, 1989; LaRue and Reckers, 1989), Kaplan et al. (1988) and Schisler (1994) found no association between knowledge and judgment. Also related to the relationship between knowledge and performance, Bonner (1990) showed that task specific knowledge aided the performance of experienced auditors in both cue selection and cue weighting components in analytical risk assessments.

In addition, Bonner (1990) later argued that as task complexity increases, domain knowledge becomes more influential. Supporting the relationship between task complexity and domain knowledge, Campbell (1988) stated that as task complexity makes a decision more difficult, domain knowledge mitigates some of that difficulty by providing a cognitive framework for evaluating more complex combinations of decision variables.

Researchers have also examined the impact of cognitive process on performance. Fuller and Kaplan (2004) focused on the cognitive fit between a person's cognitive style and task characteristics. They claim that auditors' cognitive style significantly interacts with task type. Their results indicated that analytic auditors performed better on analytic tasks than on intuitive tasks. Likewise, intuitive auditors performed better on intuitive tasks than on analytic tasks. Also related to cognitive processing, Rose and Wolfe (2000) examined the influence of cognitive load on knowledge acquisition performance. They showed that when explanations in a computerized decision aid are integrated into its problem-solving steps, cognitive load is reduced and users acquire more knowledge from aid use.

Accountants and auditors are clearly exposed to interruptions that break their concentration and create stress. These interruptions could either be task related (such as a notification pop-up from the tax aid software), or non-task related (receiving an e-mail from a co-worker on another topic). However, the extant literature has yet to analyze this area of research. The majority of the existing research that has investigated performance via laboratory environments has failed to integrate interruptions into their simulated work environment. In this regard, failure to include interruptions into performance analyses gives an inaccurate estimate of the actual performance. By taking into account the presence of interruptions, we not only increase the realism of the study but also improve the external validity of the experiment. This research analyzes the impact of interruptions on financial task performance and provides recommendations to managers to minimize the deleterious consequences.

3. Interruptions: theoretical development and hypotheses

In this section, we differentiate between interruptions and distractions, explain our interruptions framework, and then develop propositions that can be used as a foundation for exploring the effects of interruptions on auditors' and accountants' performance.

3.1. Background on interruptions

Interruptions are defined as uncontrollable, unpredictable stressors that produce information overload, requiring additional decision maker effort (Cohen, 1980). Interruptions typically result in a discontinuation of the current activity (O_Conaill and Frohlich, 1995). Distractions, on the other hand, are stimuli that direct attention away from the ongoing activity, but do not require a response (such as background music). Distractions intrude on sensory channels that are different from those required by the primary task (Cohen, 1988).

As the amount of input to a system exceeds the capacity of the system to process it, information overload can occur (Milford and Perry, 1977). Previous literature in this area describes a variety of causes of information overload associated with the use of information technology. The characteristics of information technology, such as the ability of IT to push information at a user—for example through e-mail (Bawden, 2001; Schultze and Vandenbosch, 1998), incoming text messages, or data verification pop-up notifications in tax preparation software—have the potential to induce information overload in the recipient. As stated earlier, interruptions typically require “immediate attention” and “insist on action” (Covey, 1990), even if they are not pertinent to completing the primary task at hand. As an example of an interruption, a financial analyst may be involved in examining a financial report but could be interrupted by a phone call or e-mail from a client which requires an immediate response.

Interruptions also force the individual to multitask by fragmenting his/her work. Studies have shown that while multitasking may increase productivity up to a certain point, after that threshold is reached workers face diminishing marginal returns (Aral et al., 2006). It is argued that the higher the rate of multitasking, the higher the cognitive switching costs between tasks. As a result, cognitive load increases, tasks pile up, and efficiency drops.

3.2. Theoretical basis for interruption effects

3.2.1. Cognitive resources allocation theory

Kahneman (1973) argues that interruptions result in capacity and structural interferences. Capacity interferences occur when the number of incoming cues is greater than a decision maker can process. Structural interferences occur when a decision maker has to attend to two inputs that require the same physiological mechanisms, such as attending two different auditory signals. Both types of interferences increase cognitive load and narrow a person's attention to one task at the cost of another (Speier et al., 1999). A person's attention on a particular task is similar to the concept of flow, defined by Csikszentmihalyi (1991) as the mental state in which a person is fully emerged in a particular task, characterized by a sense of energized focus and involvement. Csikszentmihalyi argues that all activities have a flow channel (defined as the balance between one's skills and the level of challenge to sustain control over an activity) that allows “optimal experience” in a task. As interruptions challenge a person (at his/her skill level) to process more information than he/she actually can, interruptions may break the flow, create anxiety and impair performance.

3.2.2. Yerkes–Dodson law

Another theoretical framework useful in examining the relationship between interruptions and performance is the Yerkes–Dodson law (Yerkes and Dodson, 1908). Yerkes and Dodson posit that a state of increased arousal (e.g., stress, anxiety) can have the potential to improve performance up to a point, dependent on task type (e.g., simple versus complex). However, beyond a certain level, arousal-creating events become intense enough to cause performance to deteriorate (Yerkes and Dodson, 1908).

3.3. The interruptions framework

What follows is our research model which explores the influence of interruptions on performance (illustrated in Fig. 1). This model illustrates the relationship between interruption antecedents (characteristics associated with the interruption, task, and individual), cognitive mediators (such as cognitive load), and downstream worker performance.

3.4. Cognitive mediators and performance

Prior research has shown that cognitive mediators (cognitive load, cognitive state, and processing mechanisms) directly influence task performance (Kahneman, 1973; Meyer, 1998). According to the cognitive capacity model, any change in cognitive load due to incoming cues will narrow the attention to one task at the cost of another. Increasing the amount of incoming information will increase the information-processing requirement and task demand, and also reduce information-processing capacity. The resultant reduced capacity will challenge the individual and impact the subject's cognitive state (i.e., through the creation of anxiety, stress, demotivation, and the like). The disturbed cognitive state will narrow the attention and cause some relevant cues to exit the memory, potentially a major detriment for performing accounting tasks.

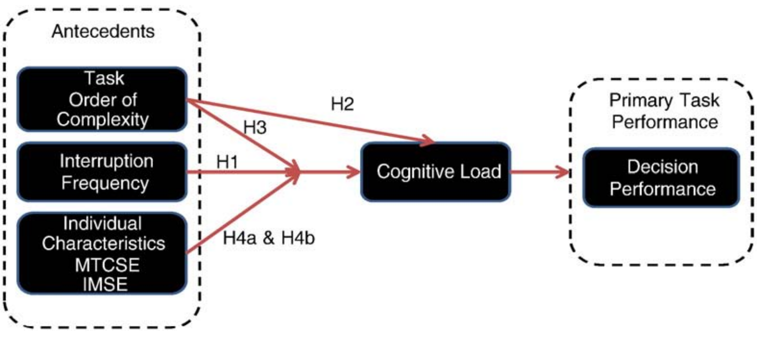

Fig. 1. Research model.

3.5. Influence of interruptions and task characteristics on performance

Technology mediated interruptions can have varying effects on performance. While some interruptions may help eliminate redundant information and improve task performance, others may break concentration. However, frequent interruptions increase the amount of information cues to be processed and decrease the amount of excess cognitive capacity (Kahneman, 1973; Baron, 1986) of accountants and auditors. This may overload their cognitive capacity and cause fatigue or anxiety if the person is engaged in tasks of high cognitive effort. This increased arousal (i.e. anxiety, fatigue, etc.) is likely to narrow attention and lead some primary task cues to exit the working memory. Therefore, we argue that:

H1. Interruption frequency will have a significant impact on cognitive load.

On the other hand, interruptions, occurring in the context of simple tasks (those requiring low cognitive effort), may help improve performance by narrowing the worker's attention and diverting it from irrelevant information cues (Kahneman, 1973; Cohen, 1980). Thus, in addition to the interruptions' frequency, the decision maker performance is likely to vary depending on the complexity of the task they are working on. In this regard, complex tasks are characterized by having multiple paths, multiple end states, conflicting interdependence, and probabilistic linkages (Campbell, 1988). Furthermore, they consist of multiple subtasks and require high cognitive effort (Vessey, 1991). For the purposes of this research, complex tasks are operationalized as accounting/auditing tasks with multiple subtasks, such as making a judgment with multiple decision rules or a comparison analysis of multiple conditions to satisfy, whereas simple tasks are operationalized as tasks with a single subtask. In addition, complex and simple tasks are counterbalanced to capture the influence of initial learning on performance.

Compared to simple tasks with a single subtask, complex tasks require processing more information cues (Payne, 1982), leaving little or no excess cognitive capacity for processing new information. However, as individuals get more experienced at a task (starting with simple tasks followed by complex), they usually become more efficient at it because they become mentally more confident and spend less time hesitating, learning, experimenting, or making mistakes (Abernathy and Wayne, 1974). Therefore we argue that, the order of the task complexity will influence decision maker's effectiveness in a task. Thus:

H2. The order of the task complexity will have a significant impact on cognitive load.

Based on the above arguments, in the presence of frequent interruptions, we argue that individuals who first work on simple tasks followed by complex tasks may have an easier cognitive transition (less anxiety, demotivation, stress, etc.), and perform better because of experience gained from initial learning, which in return reduces the cognitive load.

Prior literature has argued that task complexity has a direct impact on performance (Blocher et al., 1986; Bonner, 1990; Asare and McDaniel, 1996). However, based on the above discussion of cognitive mediators, we argue that the resulting cognitive load from a particular task (in the presence of frequent interruptions) is a determinant of performance. Therefore, and as illustrated in Fig. 1, we hypothesize the following:

H3. The interaction between the order of performing tasks of varying complexity and interruption frequency has a significant influence on cognitive load.

3.6. Individual characteristics and performance

Individual characteristics can also play an important role in task performance. For example, past research has shown that females are more easily distracted then males when performing complex tasks (Silverman, 1989). Other individual characteristics that may play a role in the performance in the workplace may also include self-efficacy related to the subject's ability to manage interruptions (interruption management self-efficacy) or the subject's ability to multitask in technology intense environments (multitasking computer self-efficacy). In this regard, past literature (Bluedorn et al., 1992) argues that monochronic individuals, or those who have a high degree of scheduling and promptness in meeting obligations and appointments (Frei et al., 1999), have a tendency to perceive time as a tangible resource and that they generally consider interruptions as negative and disruptive. Moreover, doing simultaneous tasks or using simultaneous media may be considered as chaotic (Cotte and Ratneshwar, 1999). As opposed to monochronic individuals, polychronic individuals perceive time as an intangible resource that cannot be directly controlled. They work on many projects at the same time, with little regard for formal time constraints (Frei et al., 1999). They time activities by events rather than a clock and see simultaneous tasks or media use as positive. Such personalities also have a tendency to treat interruptions as equivalent to planned activities (Bluedorn et al., 1992).

Based on the above explanation, we argue that polychronic decision makers exposed to frequent interruptions would be better at interruption management and thus will be less overloaded, as opposed to monochronic individuals who consider simultaneous activities as chaotic. Therefore, as illustrated in Fig. 1, we propose the following hypotheses:

H4a. The interaction between multitasking computer self-efficacy and frequency of interruption will have a significant influence on cognitive load.

H4b. The interaction between interruption management self-efficacy and frequency of interruption will have a significant influence on cognitive load.

4. Methodology

The hypotheses are tested in a controlled laboratory experiment, with one between-subjects factor and one within-subject factor. Task complexity is manipulated as the within-subject factor with two levels (complex and simple), whereas the between-subjects factor is interruption frequency (low, high).

A pilot test with no interruptions was conducted prior to the main study to measure task completion time for estimating the appropriate time for introducing interruptions. The participants were given the same set of questions and their completion of each question was timed. This provided an estimate on total completion time as well as the spread of interruptions throughout the experiment. The subjects who participated in the pilot test were excluded from the actual experiment.

4.1. Participants

The sample consisted of 257 business students enrolled in an undergraduate information systems course offered by the college of business in a large northwest university. Part of this course involved familiarization with spreadsheet software traditionally used in business environments for solving financial tasks. Subjects were given one extra-credit point for participating in the study. The average age of the participants was 20.6, and the gender distribution was 44% female and 56% male.

A monetary reward of $5 was promised to the top 1% of performers. The top performers were sorted with respect to minimal task completion time and maximal test score.

Even though students may be unrepresentative of professional accountants or auditors in terms of knowledge and experience, and they tend to be very homogenous, it has been shown that this does not necessarily translate into stronger tests or effect sizes (Peterson, 2001). Further, the purpose of this original research was not immediately to extrapolate our results to professional accountants or auditors but rather to study the effect of interruptions on financial task performance at a more fundamental level, a phenomenon that we believe can reasonably be studied in student populations (Ashton and Kramer, 1980; Mook, 1983; Peecher and Solomon, 2001). In order to increase generalizability, we have employed a task appropriate for college students, as suggested by Peterson (2001).

4.2. Task

In the experiment, the participants performed multiple decision-making tasks that were similar to financial analysis. Participants were given questions that involved addition, counting, and comparison analysis on biannual cost estimates of a parking lot and predicted cost estimates (tax costs, capital costs, advertisement costs, etc.) of a mall construction. For example, they were asked to compare different months' tax estimates, advertisement costs, and the like based on certain decision criteria. The presentation format of the tasks is in cognitive fit to optimize the mental processing (Vessey, 1994). In other words, the task and its representation emphasize the same type of information which helps cognitive processing of the information. Therefore, the task is presented in its appropriate processing format, i.e. symbolic (table) format. Examples of the simple tasks, complex tasks, and interruption items are illustrated in Appendix A.

4.3. Treatment conditions

The two treatment groups were given a total of 16 tasks; 12 simple tasks and 4 complex tasks. The subjects were randomly assigned to treatments which are explained below. The experimental design is presented in Table 1.

The goal of this experiment was to compare the subject's decision accuracy during high and low frequency of interruptions in simple and complex primary tasks. Thus, treatment I consisted of measuring the decision accuracy for both the simple and complex tasks while subjects were exposed to low frequency interruptions. Treatment II consisted of measuring the decision accuracy of the same tasks under high frequency of interruptions. Thus, each participant was assigned to complete both simple and complex primary tasks (counterbalanced within each group) while being subjected to one of the interruption conditions (high or low interruption frequency, as illustrated in Table 1).

Task complexity was manipulated (two levels, simple and complex) as a within-subjects factor. Simple primary tasks required the individual to perform only one subtask, such as pointing out a data point from the specified table. Complex tasks required the individual to perform multiple subtasks simultaneously or sequentially as defined by Buffa (1980) and Campbell (1988), such as making a decision with three different decision rules.

Interruption frequency was manipulated (two levels, high and low) as a between-subjects factor. The pilot test results indicated that interrupting subjects four times was considered a low frequency of interruptions, and eight times as a high frequency of interruptions.

Dependent upon the condition, the participants were interrupted by means of pop-ups tasks, which appeared in a large window covering the screen. Interrupting participants in mid-process were shown to cause greater cognitive capacity interference and forgetting than interruptions that occur at the beginning or end (Corragio, 1990a,b). Each interruption task window required students to answer a question and select “submit answer” and “exit” buttons.

4.4. Procedure

Participants were randomly assigned to the treatment conditions. The treatments ran simultaneously. An experiment script was prepared to assure consistency in instructions across experiment sessions. Participants were given an initial pretest to measure all the control variables explained below. Following completion of this phase, each participant was assigned to a primary task to be completed.

There were a total of 12 simple tasks and 4 complex tasks (for samples of tasks, see Appendix A). After completion of each task (simple or complex), a posttest was delivered to the participant as the check for the efficacy of the manipulations. After completion, the next task appeared on the screen, which was followed by a posttest.

4.5. Dependent variables

The primary dependent variable was decision accuracy, measured by evaluating whether the participant got the correct answer or not. Each problem within a task category had an optimal solution (either numeric or nonnumeric), and each participant earned zero points if the given answer did not match the optimal answer and one point otherwise. The total score for decision accuracy was an aggregate of numeric scores.

Table 1
Treatment Conditions.

	Interruption frequency (low)	Interruption frequency (high)
Task complexity (simple) Task complexity (complex)	Treatment I	Treatment II

4.6. Scales

To control for individual differences in experience with computerized media, which has been shown to be a potential confound in constructs (Jih and Reeves, 1992) and ability to cope with interruptions, the study controls for multitasking computer self-efficacy (MTCSE) and interruption management efficacy (IMSE), respectively. Multitasking computer self-efficacy is defined as a person's perception of the ease of computer use regarding concurrent execution of two or more tasks by using a single central processing unit. It is argued that polychromic individuals who are capable of multitasking on computer programs will be able to complete the given tasks in shorter time periods and more accurately than monochronic individuals. On the other hand, interruption management self-efficacy is defined as a person's ability to cope with interruptions, such that these stressors do not depreciate one's performance. Given that there are no established scales for MTCSE and IMSE, the researchers conducted scale development for these two measures. We explain this process below.

4.6.1. Item generation

In item generation, the primary concern was content validity, which may be viewed as the minimum psychometric requirement for measurement adequacy and is the first step in construct validation of a new measure (Schriesheim and Eisenbach, 1991). Both the scales were generated based on the definition of the constructs that were obtained by means of searching past literature that explained these constructs (e.g. Speier et al., 1999). Based on this search, Schwarzer and Jerusalem's (1995) general self-efficacy scale was adjusted to generate scale items for the MTCSE scale.

4.6.2. Evaluation of the items

The evaluation of scale items followed the recommendations from Kline (2005). After theoretically deriving the items, scales were subjected to a content validity assessment by two faculty members and four doctoral students who were asked evaluate the clarity and quality of the definitions and items. Furthermore, subject-matter experts were asked to classify each randomly ordered item to one of two categories and an "other" category. Those items that were assigned to the proper *a priori* category more than 80% of the time were retained for use in the questionnaire. For example, MTCSE included items such as "I believe I have the ability to work effectively on more than one task on the computer at once; I believe I have the ability to shift from task to task effectively on the computer," IMSE was composed of items such as "I believe I have the ability to reengage in work quickly after being interrupted by another task; I believe I have the ability to maintain my concentration even when interrupted by another task."

4.6.3. Scale properties

Adequate domain sampling and parsimony are important to obtain content and construct validity (Cronbach and Meehl, 1955). In this regard, the scales developed in this research include six items each, considered an appropriate number by Kline (2005).

An exploratory factor analysis with MPlus 4.0 was used to evaluate if the parent rating scale measured the two factors (IMSE and MTCSE). Results showed that the two-factor model was the best fitting model with RMR = 0.043, and RMSEA = 0.019. Next, with a different sample, a confirmatory factor analysis was conducted using MPlus (Version 4.0; Muthén and Muthén, 2006). Results showed that both the factors have item loading above 0.8 and factor correlations below 0.2 (see Table 2), which supports discriminant validity of the scales. Cronbach's alpha was used to estimate the internal consistency across items, which were 0.977 and 0.969 for the MTCSE and IMSE, respectively. The factor loadings are presented in Table 2.

Moreover, Paas and van Merriënboer (1994) argue that the "mental effort" spent by the decision maker is argued to be essence of cognitive load. Therefore, this research will be measuring changes to cognitive load via mental effort to estimate the impact of interruptions on the decision maker. Thus the cognitive load scale has been adapted to this context from Eveland and Dunwoody (2001) which follows this premise. The Cronbach's alpha was 0.89 for the scale.

5. Analysis

Data was screened for possible outliers. Scale items had no extreme skewness or kurtosis that violated normality assumption. Furthermore, psychometric properties of the scales were evaluated by means of

Table 2
Promax factor loadings for the MTCSE and IMSE scales.

	MTCSE	IMSE
I1	0.808	0.118
I2	0.884	0.082
I3	0.905	0.064
I4	0.933	0.046
I5	0.709	0.177
I6	0.871	0.056
I7	0.140	0.813
I8	0.050	0.910
I9	0.065	0.867
I10	0.086	0.844
I11	0.013	0.885
I12	0.129	0.789

confirmatory factor analysis and reliability analysis. Objective measures were employed to reduce common method bias.

To understand the mediating influence of cognitive load on the relationship between task complexity and performance, we conducted a structural equation modeling analysis by means of MPlus 4.0 software.

5.1. Hypotheses testing and structural regression model

In testing our hypotheses, an analysis of variance is first provided to assess the main and interaction effects of order of task complexity, interruption frequency, and individual characteristics on cognitive load (see Table 3). The structural regression model results are then presented and provide an assessment of the hypothesized relationships within the full research model. Lastly, the results of a multiple group analysis, using the same structural regression model, offer additional support for the hypothesized treatment interactions.

5.2. Analysis of covariance

An analysis of covariance was first performed on part of the research model to investigate the effect of interruption frequency, order of task complexity, and individual characteristics on cognitive load. The results, shown in Fig. 2 above, support the hypothesized relationships, with all main effects and the interaction effect being significant.

5.3. Structural regression model

The structural regression model was initially run with all hypothesized relationships except the interactions. Model results, including standardized path loadings, variance explained in each endogenous construct (square multiple correlations), and fit statistics, are shown in Fig. 2. All hypothesized effects were significant at $p<.001$, and the model fit was acceptable with CFI (above 0.9), RMSEA $<.05$, and the ratio of chi-squared to degree of freedom $<3:1$.

Table 3
ANOVA results for cognitive load.

Source	Mean square	*df*	*F*	Sig
Order of complexity	75.86	1	48.88	0.001
Interruption frequency	12.94	1	6.71	0.011
Order of complexity interruption frequency * IMSE	9.90	2	4.63	0.032
Interruption frequency * MTCSE	8.27	2	4.01	0.047
R-squared = 0.39 (Adjusted = 0.37)				

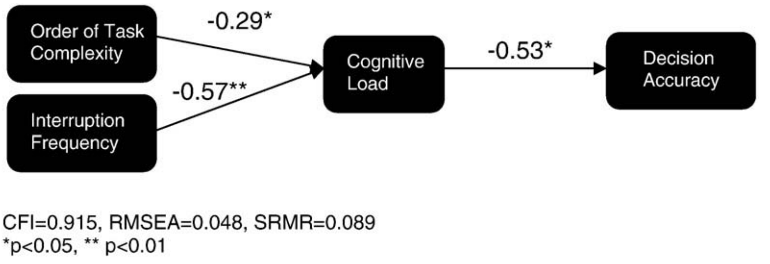

Fig. 2. Structural regression results.

Separate multiple group analysis approach was used to test the moderating effect of order complexity on the relationship between interruption frequency and cognitive load, and the effect of interruption frequency on the relationship between individual characteristics and cognitive load within the proposed research model. This approach, as described by Byrne (2001), involves specifying two subject groups (simple–complex and complex–simple), one for each treatment of IMSE (low and high) and MTCSE (high and low), and using the same structural regression model previously shown in Fig. 2 for each group.

For the two groups of order of complexity, other than the path from interruption frequency to cognitive load, the same factor loadings, error terms, covariances, and path weights are freely estimated. This one path weight is constrained to be equal across the two treatment groups. Structural regression model results are then generated for two models: a constrained model, where the path weight between interruption frequency and cognitive load is constrained to be equal across all treatment groups; and the default model, where this path weight is freely estimated. The chi-squared statistic is then used to assess whether the models are different. A significant chi-squared statistic means that the models are different and the path weight from interruption frequency to cognitive load is different across treatment groups.

Similarly, the procedures are repeated to test the moderating effect of IMSE and MTCSE on the relationship between interruption frequency and cognitive load.

We present the results for the multiple group analysis in Table 4 which supports the hypothesized moderating relationships. The chi-squared statistic for the model comparison was 3.44 and was significant at a *p*-value of 0.046. The path weights for the effect of interruption frequency on cognitive load for two groups of order complexity are 0.35 and 0.53. Similarly, the effect of interruption frequency on cognitive

Table 4
Test for moderating effect of vividness using multiple group (treatment) analysis technique in SEM.

	Order complexity treatments	
	Simple–complex	Complex–simple
Standardized regression paths		
Interruption frequency → cognitive load	−0.35	−0.53
Model comparison Chi-square/*df* = 3.44, *df* = 1, *p*-value = 0.046		
	IMSE	
	Low	High
Standardized regression paths		
Interruption frequency → cognitive load	−0.52	−0.41
Model comparison Chi-square/*df* = 6.58, *df* = 1, *p*-value = 0.022		
	MTCSE	
	Low	High
Interruption frequency → cognitive load	−0.56	−0.33
Model comparison Chi-square/*df* = 6.95, *df* = 1, *p*-value = 0.019		

load for treatments of IMSE and MTCSE were also significant. All significant paths in the structural regression model presented in Fig. 2 remained significant in the multiple group analysis.

6. Results

The results indicate that cognitive load impacts performance in the form of task accuracy. In particular, we found a significant negative indirect influence of frequency of interruptions on decision accuracy through cognitive load for task accuracy. This provides support for H1. Furthermore, the presentation order related to task complexity had a significant negative indirect effect on the decision accuracy for decision accuracy. This indicates the presence of a learning curve associated with tasks, which helps with later tasks. Similarly, the interaction between frequency of interruptions and order of task complexity had a significant influence for task accuracy. This influence was found marginally significant ($p = 0.056$) with the ANOVA analysis, and SEM analysis also showed it to be significant. Thus, H3 is also supported.

Furthermore, the results also support H4a and H4b. The path coefficients for the interaction between MTCSE and IMSE are both significant ($p < 0.05$). This result indicates that multitasking self-efficacy and interruption management self-efficacy help to reduce cognitive load. In other words, higher IMSE and MTCSE lead to better coping mechanism during frequent interruptions.

The study also evaluated the adequacy of the manipulations. The manipulation checks were successful, level of interruption frequency and task complexity were perceived as intended, and actual task versus interrupting task difference was adequate. There were 16 subjects who were dropped from the data set due to an incomplete response.

7. Limitations

One limitation of this study is the use of college students as surrogates for accounting professionals. Professionals may be less sensitive to the effects of interruptions on financial task performance because of training or experience. While the use of experienced practitioners may provide greater assurance regarding the external validity of the experiment, the primary purpose of this research was to study the impact of interruptions on financial task performance at a foundational level. Furthermore, the theoretical importance of this study applies principally to internal validity, and the utilization of student participants is appropriate in this context (Mook, 1983; Ashton and Kramer, 1980; Peecher and Solomon, 2001). Secondly, even though the MTCSE and IMSE scales demonstrated adequate psychometric properties in this study, additional research is warranted to insure that the scales are reliable and valid across different settings and population groups.

8. Conclusion and future research

There is lack of research regarding the systematic evaluation of the effects of interruptions on work productivity of accountants and auditors. This research explored (among other variables) the influence of interruption frequency on worker performance. However, other interruption characteristics might also have a significant influence on performance, including factors such as the timing, complexity, or duration of interruptions. Further, while this research also explored limited task characteristics (complexity); other task characteristics (such as importance or novelty) also deserve attention.

This paper extends the Speier et al. (2003) work in various dimensions. First, we introduce the cognitive mediators as the mediating variable between interruption antecedents and performance. Moreover, we provide a more systematic and comprehensive model that includes more factors that influence performance in the presence of interruptions. In particular, the model stresses the importance of individual characteristics as a major factor in performance, and develops new scales related to such characteristics.

Future research may examine more comprehensive taxonomies of interruption in task characteristics and the effects of such interruptions in systematic ways. After establishing baseline performance using more tightly controlled experimental designs employing student groups, future research on the impact of interruptions on performance may be extended by examining this relationship with accountant and auditor performance in more realistic settings.

Appendix A. Sample Experiment Questions

Simple Task Questions:

1. What is the total number of periods where capital cost was more than taxes?
2. What is the total number of periods where capital cost was more than taxes?
3. Which parking lot was the most expensive during March?
4. Which parking lot had the least amount of empty spots per hour during the month of April?

Complex Task Questions:

1. If the cost estimates are as follows for a month, then the production manager can increase worker's wages.
   1. Total cost less than $100,000,
   2. Transportation cost at most 2 times the taxes,
   3. Advertisement cost equal or less than $36,000.

   During which month(s) (if any) can the production manager increase wages?
2. If the 80% of the revenue obtained in December from the parking lots will be used to cover the cost of mall construction in June and the remaining 20% of the revenue from December goes to cover the cost for next month, July, then how is the cost in September covered?

Interruption questions:

Please refer to Table 2. In 2004 how many categories had an online spending less than 5%?
Please refer to Table 2. During 2005, how many of the listed categories had less than 1 billion dollars online retail spending?
Please refer to Table 1. How many departments had an increase in the number of graduate student from 2000 to 2001?

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