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Please Do Not Disturb: Managing Interruptions And Task Complexity

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Abstract

The increasing use of computer-mediated communication (CMC) by knowledge workers in problemsolving environments intensifies the need for empirical evidence on the effects of interruption on users’ problem-solving performance. Email and instant messaging are common desktop and mobile applications that frequently seek the user’s attention via audible and visual cues. This study is concerned with whether the effects of immediate interruptions are more disruptive than negotiated interruptions to users’ problem-solving performance. It recognizes the importance of task complexity in explaining the relationship between the effects of interruption type and users’ performance in the context of problem-solving. An experiment is used to capture how user interruptions in the form of instant messages that demand users’ immediate response and e-mail messages that allow users to negotiate a delayed response could affect users’ problem-solving performance across simple and complex tasks. Results indicate task complexity negatively moderates the effects between immediate and negotiated types of interruptions from CMC on users’ problem-solving performance. Interruptions that demand users’ immediate response were found to degrade users’ efficiency and accuracy for complex tasks, compared to interruptions that allow users to negotiate a delayed response, while the effects between both types of interruptions were not significantly different for simple tasks.

Keywords: interruptions, task complexity, decision accuracy, computer mediated communication.
INTRODUCTION

Technological advances in computer-mediated communication (CMC) are meant to facilitate more effective user communication through concurrent interactivity (Swartz 2003), and with improved mobility by means of wireless networks (Gay & Hembrooke 2002). However, people increasingly face the problem of user interruption that results from the interaction between human and machine (McFarlane 1998; Schmandt et al. 2000; Franke et al. 2002; McCrickard et al. 2003; Russell et al. 2007; Garrett & Danziger 2008). The emergence and rapid adoption of CMC technologies in recent years, such as instant messaging and mobile e-mail systems, carries widespread ramifications not only for enterprises’ communication strategies (Gartner 2004), but also the productivity of intended users (Intel 2004). Vendors of instant messaging (IM) systems, including AOL, Google, Microsoft and Yahoo!, have extended the interoperability of IM platforms that will pave the way for greater enterprise use of IM (Forrester 2004). Corporate e-mail deployment is being increasingly mobilized with the introduction of mobile e-mail with push services (e.g. BlackBerry), and many mobile software infrastructure vendors have made e-mail deployment more pervasive by offering mobile e-mail support in their products (Gartner 2004). Social networking client capability built into most modern smart-phones has further intertwined social and work activities.

Despite the trends in CMC technological progress that are beneficial for particular communicative purposes; the problem of user interruption is ultimately an unavoidable side effect from the use of computer-mediated communication (Franke et al. 2002; Schmandt et al. 2000). Under certain conditions, people are able to perform several tasks concurrently. However, the problem manifests itself where people’s cognitive limitations render them vulnerable to mistakes when they multitask due to the onset of interruptions (McFarlane 1998).

People in their capacity as knowledge workers often face diverse problems in their work environments (Kidd 1994), thus whether from CMC technology driven interruptions negatively affects the users’ problem-solving processes is an important research issue. The research landscape is beginning to change as the influence of interruptions on users of computer-mediated communication grows in importance (Cutrell et al. 2001). The literature has attributed the disruptive effects of user interruptions to the nature in which these interruptions are presented to users, and the limitations of users’ cognitive capabilities in handling the onset of interruptions. Although there have been several empirical studies conducted in this area, the effects of user interruptions from computer-mediated communication are still not well understood.

This research pursues the problem of how interruptions from computer-mediated communication would negatively affect users’ performance, in particular, their problem-solving accuracy. In particular, it addresses the research question, do immediate interruptions result in more decision making errors than negotiated interruptions, and how does task complexity influence this?.

This research makes three important contributions: (1) it addresses how the effects of immediate and negotiated types of interruptions might differently affect users’ task performance across simple and complex tasks; (2) it furthers our understanding about user perceptions of interruption and distraction across interruption type and task complexity; and (3) it broadens our knowledge on the effects of interruptions from computer-mediated communication on problem-solving processes and outcomes.

LITERATURE REVIEW

Interruptions are typically considered disruptive in nature, often hindering task performance and effectiveness (Jett and George 2003). Cohen (1980) describes interruptions as uncontrollable, unpredictable stressors that produce information overload, and requiring additional effort by users to attend to it. The literature has shown that research on the nature of interruptions dates back to the early Zeigarnik (1927) experiments (Burmistrov & Leonova 1996; Gillie & Broadbent 1989; McFarlane 1998; Zijlstra et al. 1999). In her experiments, Zeigarnik (1927) used a range of tasks from simple manual activities such as stringing beads to more cognitively complex activities such as
solving puzzles (Gillie & Broadbent 1989). Her participants were instructed to stop working on tasks prior to completion and switch to another task (Czerwinski et al. 2001). Her empirical results were later identified as the Zeigarnik Effect (Van Bergen 1968), which describes how people were able to recall the details of interrupted tasks better than the details of uninterrupted tasks after interruptions (Altmann & Trafton 2004; Czerwinski et al. 2001; Gillie & Broadbent 1989; McFarlane 1998).

Empirical research on user interruptions has attributed the disruptive effects of interruptions to the nature in which these interruptions are presented to users. In much the same way as human-human communication, interruptions can insist on an immediate response from users or allow users to negotiate a delayed response in computer-mediated communication. Previous empirical findings have suggested that large differential effects on users’ task performance exist between immediate and negotiated types of interruptions (McFarlane 2002). According to McFarlane (1998), immediate interruptions are events that interrupt a user in a way that demand their attention and expect users to pause their tasks and interact with it. Negotiated interruptions are events that would give a user control over when or whether to deal with it at a convenient point in time.

In computer-mediated communication, commercial applications such as e-mail clients and instant messaging support rudimentary negotiation of user interruptions, where users have some level of control over when to read their incoming messages (McFarlane & Latorella 2002). On the other hand, these interruptions can also be immediate in nature (Lovejoy & Grudin 2003; Speier et al. 2003), where people have been found to be amenable in switching from the primary task to the interruption immediately (Czerwinski et al. 2000a).

So while there has been recent research activity on the disruptive effects of interruptions from computer-mediated communication on users’ task performance (for example, Avrahami & Hudson 2004; Cutrell et al. 2001; Czerwinski et al. 2000a; 2000b; Speier et al. 2003); these empirical studies have primarily focused on the immediate nature of these user interruptions, yet neglecting user interruptions that allow people to negotiate delayed responses, as they would in normal human conversations. Of importance, empirical studies in the literature suggest users may perform differently in their tasks when these users respond to interruptions immediately or when they negotiate their responses to interruptions (McFarlane 2002; Hodgetts & Jones 2003; Iqbal & Horvitz 2007a, 2007b).

Furthermore, some empirical studies in the literature suggest the effects of interruptions on the problem-solving performance of users can vary across task complexity (Jett & George 2003; Speier et al. 2003). However, many empirical studies in this area have investigated the effects of user interruptions on users’ performance in relatively simple primary tasks (for example, Bailey et al. 2001; Cutrell et al. 2001; Czerwinski et al. 2000a; 2000b; McFarlane 2002), and it is not clear whether and how their findings would apply to a more complex domain of tasks. This understanding of the literature and lack of clarity around the issues leads to the first hypothesis:

**H1:** Task complexity moderates the effects of interruptions on users' decision accuracy, such that immediate and negotiated interruptions more negatively affect complex tasks than simple tasks.

This study also draws on the methods of interruption coordination by McFarlane (1998) for investigating the research issue of whether the effects of immediate interruptions are more disruptive than negotiated interruptions to users’ problem-solving performance. The differences between both immediate and negotiated types of user interruptions emphasized the onset of the interruption and the amount of user control over when and how to attend to the interruption (Franke et al. 2002; Hodgetts & Jones 2003; Robertson et al. 2004; McFarlane & Latorella 2002).

According to Simon et al. (1986), coping with complexity is central to human problem-solving and decision-making. Previous empirical findings in the literature have suggested that the effects of interruptions on the task performance of users can vary across task complexity (Jett & George 2003; Speier et al. 2003). Interruption/decision-making theory (IDT) by Speier et al. (2003) is used for
extending the research issue of whether the effects of immediate interruptions are more disruptive than negotiated interruptions to users’ problem-solving performance across simple and complex tasks. The differences in how people process information across simple and complex tasks are important for understanding the effects of user interruptions on human problem-solving and decision-making performance (Speier et al. 2003). This leads to the second hypothesis:

**H2**: Task complexity moderates the effects of interruptions on users’ perceived interruption, such that immediate and negotiated interruptions more negatively affect complex tasks than simple tasks.

The interruption/decision-making theory (IDT) also provides a theoretical perspective for understanding the influence of interruptions on users’ problem-solving performance across tasks of different complexity. According to Speier et al. (2003), the origins of the theory are founded in a related research stream investigating the influence of distractions on users’ decision performance (Baron 1986), where empirical studies found that distractions aid in decision performance for simple tasks but elicit deleterious effects on decision performance for complex tasks (Boggs & Simon 1968; Hockey 1970). Empirical support for the theory has been demonstrated for distractions (Boggs and Simon, 1968; Hockey, 1970) and interruptions research (Speier et al., 1999; 2003). This study aims to further test this relationship. This leads to the third hypothesis:

**H3**: Task complexity moderates the effects of interruptions on users’ perceived distraction, such that immediate and negotiated interruptions more negatively affect complex tasks than simple tasks.

Figure 1 presents the model of the research framework that investigates how the independent variables of interruption type (immediate or negotiated interruption) and task complexity (simple or complex task) will affect the dependent variables for problem-solving performance.

This research seeks to provide empirical evidence of the research problem by studying the differential effects between the types of user interruptions that are initiated from the use of computer-mediated communication, which may affect the problem-solving processes of users. This research also recognizes the importance of task complexity in the context of problem-solving, which can be central to explaining the relationship between the effects of user interruptions and the problem-solving performance of users.
3 METHOD

The experiment in this study was designed to make a contribution to the existing body of work on user interruptions from computer-mediated communication, where the majority of research work has been laboratory experiments. This study seeks to test predictions that were derived from the theoretical work in the literature, and an experimental design will allow the empirical results to be directly compared to previous empirical work (Lam 1995). Quantitative surveys were used to elicit user perceptions about the disruptive nature of user interruptions to their problem-solving performance in tasks.

The effects of user interruptions on human task performance can be influenced by several factors: (1) the people involved in the interruption, (2) the task(s) the person is attempting, (3) the interruption itself, and (4) the working context or environment (McFarlane 1998). Controlled experimentation can allow a direct study of the dependent variables from the effects of manipulating the independent variables (Benbasat & Nault 1990), by controlling other variables so as to permit reliable inferences about the cause and effect of immediate and negotiated interruptions on users’ problem-solving performance across different task complexity (Mason 1989).

The problem tasks are a simplified model of a class of common problems that define the way in which people are cognitively engaged in three stages of information processing: input, processing and output (Bonner 1994). It is aimed at maximizing the external validity of the results for an important requirement of real world problem-solving situations, where an individual concentrates on analyzing a problem, and engages his/her cognitive capabilities in processing the solution to the problem. Examples of common problems that require people to systematically process information in this way, that is, the type of problem-solving undertaken by knowledge workers would be cryptography, code deciphering, programming and architectural design. The use of student participants to capture and generalise the effects of individual problem-solving performance is well founded in decision-making research (Dollinger et al. 1997; Speier et al. 2003). Moreover, the participants intend to graduate and become employed as junior IS and IT professionals, where they would be initially in problem-solving situations with limited task experience.

3.1 Subjects

The subjects in the study were 40 undergraduate students (25 males and 15 females) enrolled in IS or IT degrees at a large Australian university. This sample size is consistent with previous experiments using a similar paradigm (McFarlane 1998, 2002). The subjects’ ages ranged from 18 to 37, with a mean age of 22.4 years. All subjects had skills ranging from intermediate to expert usage of computers, so they had a reasonable level of proficiency with computing tasks. They were frequent users of e-mail systems and adept at basic e-mail functions. While 20% of the subjects rarely used instant messaging (IM) systems, 80% of the subjects used instant messaging occasionally and 87.5% of all subjects have a reasonable level of proficiency with IM functions.

3.2 Materials

The experimental tasks were performed on a PC with a standard mouse. The tasks were run in an integrated Microsoft Active Server Pages (ASP) Web application displayed in a single browser window in the center of the screen. Interruptions were triggered as JScript pop-up windows to simulate an instant message or an e-mail notification. Subjects’ responses were captured unobtrusively in the background to a Microsoft Access database using VBScript.

Figure 2 shows an example of what a user would see during the comprehension process stage for a simple problem task. For a complex problem task, the number of transpositions required is increased.
Figure 2. Examples of simple and complex problem tasks during the comprehension process

Figure 3 shows an example of what the user would see during the decision-making process stage for the task proposed in Figure 2.

Figure 3. Examples of simple and complex problem tasks during the decision-making process

Figure 4 shows an example of the interruption task that may be presented as a instant message (immediate) or an e-mail message (negotiated). According to Gillie and Broadbent (1989), the task requires subjects to perform addition of two-digit numbers; however the numbers were coded as letters. To decode the problem, a random displacement value was given (between 2 and 9) within the message body, indicating which letter represents zero for that task. The value range ensures a comparative degree of complexity. The alphabet was displayed in upper-case letters within the message body. Subjects were required to key in the answer to the problem in digits, and were not expected to recode the answer into letters.
3.3 Design

A two factor, within-subjects, Latin squares design was chosen as the appropriate design for this experiment because the dependent variables are measured repeatedly on the same subject under each of the different treatment conditions (Trotman 1996). The Latin squares ordering used is counterbalanced grouping scheme. This ordering is chosen because it ensures that each condition follows every other condition exactly once (Keppel 1991; Wagenaar 1969; McFarlane 2002), and it has been used effectively in previous empirical work to control for possible carryover effects (Hinckley 1997; McFarlane 2002).

3.4 Procedure

The experiment involved the participation of forty undergraduate students. Each subject was randomly assigned to one of four order groups that defined the counterbalanced ordering of the presentation of the four treatments. Each of the four treatments in the experiment was administered with a discrete combination of the two independent variables: interruption type (immediate and negotiated interruptions) and task complexity (simple and complex tasks). Subjects received all four treatments, and their decision accuracy (the dependent variable) was measured under the four treatment conditions.

Each subject performed a sequence of twelve problem tasks set in the form of Q&A (question and answer format) in a short and intense session to avoid the confounding influences of fatigue and boredom. The tasks were based on previous research work on anagramming (Russell et al. 2003), the concept of backtracking in the n-Queens problem (Abramson & Yung 1989), and the concept of recursion in Towers of Hanoi (Burch 1999). Each problem task involves three discrete shapes and subjects were given instructions to change the order of the shapes. By default, each problem task was 2.5 minutes long; therefore the maximum total time for a subject to complete all the problem tasks was 30 minutes. Subjects were permitted to complete each task before the default timing. Before the commencement of the sequence of problem tasks, each subject practiced two trial tasks to familiarize themselves with the cognitive requirements of solving the problem tasks. The contents of the problem tasks were not varied between treatment conditions; only the sequence of the tasks was varied between the treatment conditions.

In the experiment, task complexity is increased with the number of information cues that needs to be processed (Wood 1986), and the number of transpositions that is required in a problem task (Russell et al. 2003). Using Bonner’s (1994) definitions of task complexity, each of these simple problem tasks involved examining at least four information cues and requires two transpositions, followed by

Figure 4. Interruption task by an instant message or an e-mail message

Message from Mr. Houghton

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

With a displacement value of 5,

What is MG + GP = ?

Reply:

Send
analyzing six decision options. Each of the complex problem tasks involved examining at least eight information cues and requires four transpositions, followed by analyzing six decision options.

4 RESULTS

The following sub-sections report the statistical analysis of the hypotheses proposed in this study.

4.1 Decision Accuracy

Decision accuracy is the degree to which a subject’s decision agrees with the accurate solution to a problem task, during the decision-making process of problem-solving. The decision accuracy was measured by the number of decision errors made by subjects under each of the treatment conditions.

Subjects’ mean decision accuracy (<1) indicated an overall high level of decision accuracy across treatments. It shows a difference (22.2 percent) between the effects of immediate and negotiated interruptions on subjects’ mean decision accuracy for simple tasks (0.275 and 0.225 respectively) and similarly, a difference (75 percent) between the effects of immediate and negotiated interruptions on subjects’ mean decision accuracy for complex tasks (0.7 and 0.4 respectively). Figure 5 illustrates the variations of subjects’ mean decision accuracy.

![Figure 5. Mean decision accuracy across experimental treatments](http://aisel.aisnet.org/pacis2011/187)

H1 posited that task complexity negatively moderates the effects of immediate interruptions and negotiated interruptions on users’ decision accuracy, such that there is no differential effect between immediate and negotiated types of interruptions on users’ decision accuracy for simple tasks, and immediate interruptions reduce users’ decision accuracy compared to negotiated interruptions for complex tasks. A repeated measures, two-factor ANOVA was used to analyze the effects of immediate and negotiated interruptions on the decision accuracy of subjects across task complexity. A significant interaction effect \(F (1,39)=4.149, p=0.048\) was found between task complexity and interruption type, which indicated that the effect of interruption type on decision accuracy was dependent upon the complexity of tasks performed by subjects.

The significant interaction effect suggests a need for further analysis to assess the effects of interruption type on subjects’ decision accuracy for each level of task complexity. The analysis showed no significant difference between the effects of immediate interruptions and negotiated interruptions to the decision accuracy of subjects in simple tasks \(F (1,39) = 0.494, p=0.486\). The analysis also revealed a significant decrease in decision accuracy \(F (1,39) = 6.882, p=0.012\) when
subjects received immediate interruptions compared to negotiated interruptions in complex tasks. H1 was therefore accepted.

4.2 Perceived Interruption

An ex-post questionnaire elicited subjects’ rankings of their perceived feeling of interruption in the treatment conditions for their problem-solving processes. Figure 6 illustrates the means of subjects’ rankings for their perceived levels of interruption.

![Figure 6. Means rankings of treatment conditions for perceived interruption](image)

As shown in Figure 6, subjects reported that negotiated interruptions mitigated perceived interruption when they are solving both simple and complex problem tasks compared to immediate interruptions. A one-way ANOVA was used to analyze the difference in subjects’ rankings of treatment conditions for their perceived level of interruption in treatment conditions for each level of task complexity during their comprehension and decision-making processes respectively. Levene’s test of homogeneity of variance was performed for each ANOVA and Brown-Forsythe $F$-ratio reported where the assumption was violated (indicated by *).

The analysis revealed a very highly significant difference in subjects’ rankings for their level of perceived interruption when responding to immediate interruptions compared to negotiated interruptions in simple tasks [$F (1,69.684)^* = 42.9, p<0.001$] and complex tasks [$F (1,78) = 56.865, p<0.001$] respectively during their comprehension process. The analysis also revealed a very highly significant difference in subjects’ rankings for their perceived level of interruption when responding to immediate interruptions compared to negotiated interruptions in simple tasks [$F (1,78) = 68.25, p<0.001$] and complex tasks [$F (1,78) = 31.88, p<0.001$] respectively during their decision-making process for the problem tasks.

4.3 Perceived Distraction

The ex-post questionnaire also elicited subjects’ rankings of their level of involvement in the treatment conditions, that is, their perceived feeling of distraction from the effects of interruption type during their problem-solving processes. Figure 7 illustrates the means of subjects’ rankings of
treatment conditions for their level of distraction perceived during their comprehension process and decision-making process.

![Means rankings of treatment conditions for perceived distraction](image)

**Figure 7.** Means rankings of treatment conditions for perceived distraction

Subjects reported that negotiated interruptions mitigated their perceived level of distraction when they are solving both simple and complex problem tasks compared to immediate interruptions. A one-way ANOVA was used to analyze the difference in subjects’ rankings of treatment conditions for their perceived level of distraction in treatment conditions for each level of task complexity during their comprehension and decision-making processes respectively. Levene’s test of homogeneity of variance was performed for each ANOVA and Brown-Forsythe $F$-ratio reported where the assumption was violated (indicated by *).

The analysis revealed a very highly significant difference in subjects’ rankings for their perceived level of distraction when responding to immediate interruptions compared to negotiated interruptions in simple tasks [$F (1,78) = 29.846, p<0.001]$ and complex tasks [$F (1,59.952)* = 83.522, p<0.001$] during their comprehension process. The analysis also revealed a highly significant difference in subjects’ rankings for their perceived level of distraction when responding to immediate interruptions compared to negotiated interruptions in simple tasks [$F (1,78) = 9.058, p=0.004$], and a very highly significant difference in subjects’ rankings for their perceived level of distraction when responding to immediate interruptions compared to negotiated interruptions in complex tasks [$F (1,78) = 12.057, p<0.001$] during their decision-making process.

5 DISCUSSION

This study pursued the issue of whether the effects of immediate interruptions are more disruptive than negotiated interruptions to users’ problem-solving performance across simple and complex tasks. It was hypothesized that task complexity moderates the effects of interruptions on users’ decision accuracy, with immediate and negotiated interruptions have a greater negative influence for complex than simple tasks (H1). Also, those subjects perceive higher negative effects for interruption (H2) and distraction (H3) with complex tasks more than simple tasks. Table 8 presents a summary of the study findings.
Hypotheses | Findings | Supported?
--- | --- | ---
H1 | For simple tasks, there is no differential effect between immediate and negotiated types of interruptions on subjects' comprehension time. | Yes
H2 | For complex tasks, immediate interruptions decrease subjects’ decision accuracy compared to negotiated interruptions. | Yes
H3 | Subjects perceived that negotiated interruptions mitigated their perception of interruption compared to immediate interruptions when they are comprehending and making decisions for simple and complex tasks. | Yes

Data analysis revealed a significant interaction effect between task complexity and interruption type on users’ decision accuracy. This interaction effect suggests that task complexity moderates (as expected) the effects of interruption type on users’ decision accuracy in the problem-solving process. Further analysis of the effects revealed that while there is no significant difference between the effects of immediate and negotiated types of interruptions on users’ decision accuracy in simple tasks, immediate interruptions significantly exacerbated users’ decision accuracy compared to negotiated interruptions in complex tasks. These results are partly consistent with the findings by McFarlane (2002), who found that immediate interruptions exacerbate users’ accuracy in their task performance compared to negotiated interruptions. However, it is found in this experiment that negotiated interruptions significantly mitigated the disruptive effects of immediate interruptions only when users are performing complex tasks but not in simple tasks, thus affirming the hypothesized assumption that task complexity negatively moderates the effects of immediate interruptions on users’ decision accuracy compared to negotiated interruptions (H1). This finding is also consistent with the results by Speier et al. (2003), who found that interruptions reduce users’ decision accuracy in complex tasks and not in simple tasks.

Furthermore, the results indicate that users perceive negotiated interruptions to be less interruptive and distracting on their tasks, offering them an ease of control over their responses to the interruptions and effectively mitigating the complexity of task resumption for them. Notable responses from subjects that summed up why user interruptions from computer mediated communication would negatively affect their problem-solving performance are, “When that instant message popped up on my screen, I forgot my answer to the problem that I was originally working on after responding to it!”, “Was halfway through to figuring out the solution when an instant message popped up, which made me start all over again in reading the question” and “It was annoying when I can’t control my responses to an instant message, especially during complex situations”. These subjective responses seemed to suggest that some form of retroactive interference is in play, where previously learned information is lost because it is mixed up with new and somewhat similar information (see Vockell 2003) This research supports McFarlane’s (1998) notion that the challenge in mitigating the disruptive effects of user interruptions from computer-mediated communication is defined in the way that the interruptions are coordinated between users and system.

A theoretical implication of this research is that the differential effects between immediate and negotiated types of interruptions on problem-solving accuracy are negatively moderated by task complexity. The findings also show that the differential effects between both types of interruptions

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Table 8. Summary of findings

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<thead>
<tr>
<th>Hypotheses</th>
<th>Findings</th>
<th>Supported?</th>
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<tbody>
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<td>Yes</td>
</tr>
<tr>
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<td>Yes</td>
</tr>
<tr>
<td>H3</td>
<td>Subjects perceived that negotiated interruptions mitigated their perception of interruption compared to immediate interruptions when they are comprehending and making decisions for simple and complex tasks.</td>
<td>Yes</td>
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</table>
widen as the cognitive complexity of tasks increases in the input and processing stages of the problem-solving process. These findings point to the importance of task complexity as a critical factor in explaining the differential effects between immediate and negotiated types of user interruptions from computer-mediated communication on users’ problem-solving performance. The findings also suggest that the effects of interruption type on users’ problem-solving performance cannot be studied independently of the complexity of tasks performed by users.

Another theoretical implication of this research is that negotiated interruptions can mitigate the disruptive effects of immediate interruptions on users’ efficiency and accuracy for complex problem-solving processes. The research findings show that as users’ cognitive resources expend with increasing complexity in their tasks, it should be possible to alleviate the burden on users’ cognitive limitations with negotiated interruptions and, in so doing, mitigating a degradation of efficiency and accuracy to users’ problem-solving performance that might result from the effects of immediate interruptions. This implication reinforces the notion that negotiated interruptions are more desirable for users in complex situations compared to immediate interruptions.

This research also has several practical implications for the use of computer-mediated communication in the workplace. The results indicate that immediate interruptions are disruptive and degrade users’ problem-solving accuracy in complex problem-solving processes. Users also found negotiated interruptions to be more desirable than immediate interruptions in their problem-solving processes. An important implication of this research is that it can help organizations in deciding how to effectively use CMC technologies to improve and not undermine users’ problem-solving processes at the workplace. An implication for organizational policy makers is that when using CMC technologies in the workplace, techniques can be implemented to mitigate unnecessary disruptive effects of user interruptions through stipulations about what purposes should the technology be used for, and what kind of content should be shared using the technology.

The research findings also have practical implications for the designers of CMC technologies. The results indicate that negotiated interruptions can mitigate the disruptive effects of immediate interruptions on complex problem-solving processes. Future designs of CMC technologies should incorporate features that enhance existing negotiation mechanisms. At a bare minimum, the system should not ‘force’ an immediate response from users but allows users to negotiate and delay their responses at a stage that would not compromise their cognitive ability to perform well in their work. In particular, designers and vendors of CMC technologies should work towards augmenting future systems with improved negotiation mechanisms that can better coordinate the interactions between the user and the system (McFarlane 1998). The long term objective of the design of CMC technologies should be continual improvements to the features of these technologies for supporting greater user efficiency and accuracy in users’ work processes.

6 LIMITATIONS & FUTURE RESEARCH

While the use of controlled experimentation in this research permitted reliable inferences to be made about the findings, the increased control afforded by a laboratory experiment was traded off against an inherent limitation of the approach to reflect realism (Mason 1989; Speier et al. 2003), primarily the generalizability of the problem tasks. Although the problem tasks were aimed at maximizing the external validity of the findings by defining the way in which people are cognitively engaged in three stages of information processing: input, processing and output (Bonner 1994), the generalizability of the findings is limited to where an individual systematically engages his/her cognitive ability in comprehending and making decisions in problem-solving processes. In a real-world setting, problem-solving processes may not be as well-defined as in the experiment due to different types of problem tasks that require varying levels of cognitive processing by knowledge workers. Future research could examine different contexts, such as CMC equipped classrooms and public spaces, with inclusion of a broader sample population and influence of factors like task experience and gender.

Another possible issue of concern during the course of the study was the timing of interruptions, that is, determining appropriate timings for administering the interruptions to have an effect of users’
problem-solving performance. While the timing of interruptions was a concern, this concern was mitigated by conducting a pilot-test on the experimental tasks and experimental treatment conditions with an initial set of interruption timings. A limitation of these interruption timings is that these timings are not precise indicators of when users’ problem-solving performance would be affected by the onset of interruptions, however given the complicated nature of interruptions, these timings were an experimental artefact for ensuring that experimental subjects have sufficient time to be involved in the problem tasks for the interruptions to have an effect on them, and the pilot test showed that the interruption timings were appropriate for that purpose.

For this study, interruptions from computer-mediated communication were administered as instant messages and e-mail messages. While forcing subjects to respond to an instant message immediately and allowing subjects to control their responses to an e-mail message may not be desirable in maximizing the external validity of the findings, forcing subjects to respond to an interruption immediately was part of the experimental treatment to simulate the situation in the real-world where computer-mediated communication often took the form of prioritized messages that require immediate attention by knowledge workers, for example, an instant message from management to an employee where both parties involved in the communication are aware of the online presence of the other party. Despite these limitations, the strengths of the research remain and the limitations are viewed as platforms for future research (e.g. push notifications of IM and email to smart phones, use of CMC in pedagogical studies, and situational awareness systems in vehicular navigation).

References


