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Exploring the impact of instant messaging on subjective task complexity and user satisfaction

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Abstract

Instant messaging (IM) technologies are being rapidly deployed in the workplace. Current studies largely focus on the adoption of IM and how IM is used. Little research has been conducted to understand the potential impact of using IM in the workplace. This paper theorizes and empirically tests how the frequency of IM interruptions and the position power of message sender could interact with an individual's polychronic orientation, that is, multitasking preference, and jointly influence employee satisfaction and subjective task complexity. The present study illustrates that polychronic knowledge workers are more satisfied with the multitasking work process deploying IM technology than monochronic ones. In addition, the effect of interruptions is dependent upon an individual's polychronic orientation. The increase in interruption frequency only reduces the process satisfaction of monochronic individuals but not polychronic individuals. Further, the polychronic orientation of message receivers also influences how they process information. When IM messages are sent from their supervisors, monochronic individuals tend to prioritize tasks and perceive a lower level of overall task complexity. The information processing of polychronic individuals seem to be less influenced by the position power of message sender.

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Introduction

Instant messaging (IM), the most popular incarnation of near-synchronous computing text chat technology among recreational users and teenagers (Grinter & Palen, 2002), is being ushered into the workplace. A recent survey found that one-third of computer users utilize IM at work to keep connected with co-workers and/or clients (Garrett & Danziger, 2007). Further, it was estimated that there would be 250 million IM accounts, inclusive of business accounts, by year 2010 (Gantz *et al.*, 2007). With its functionality for interaction and 'outeraction' (Nardi *et al.*, 2000), IM not only supports informal communication in the workplace where email, phone and fax are already extensively adopted, but also facilitates some of the processes that make evasive enterprise-wide information sharing possible (Luo *et al.*, 2010). The widespread deployment of IM in the workplace is attributed to key attributes of IM such as *synchronous* response and *immediate* presence awareness and event notification. In essence, presence notification/awareness feature allows employees to find out who (i.e., internal and/or external business constituents) are online and available for instantaneous communication. Messages sent out over the IM

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platform are more likely to elicit a response in a real-time manner, and a near-synchronous communication could be established among multiple communication parties. As IM presents a revolution in enterprise communication, many organizations are leveraging IM as a valuable tool to improve inter-organizational collaboration and work scheduling (Quan-Haase *et al*., 2005). In addition, some firms have integrated IM into their IT infrastructure in order to build a sense of social presence and community, diminish transactional distance, and reduce the potential for misunderstanding as well as create a multitasking work environment (Cummings, 2004; Cameron & Webster, 2005; Rennecker & Godwin, 2005).

Initial efforts in academia have been devoted to studying the application, adoption and potential consequences of IM in the workplace (Cameron & Webster, 2005; Li *et al*., 2005; Garrett & Danziger, 2007; Luo *et al*., 2010). As prior studies have found that the deployment of IM in the workplace may raise concerns about the potential detrimental effects on organizational communications, much attention to date has focused on understanding the impact of IM on the level of interruptions in the workplace (Cummings, 2004; Rennecker & Godwin, 2005; Garrett & Danziger, 2007). In particular, Rennecker & Godwin (2005) found that unstructured IM use may increase communicative workload and interruptions because such IM features as a pop-up notification window and pressure for users to respond in a multitasking work environment may raise the level of workload of employees, thereby reducing their job satisfaction.

These prior studies have only provided partial understanding of the consequences of IM communication due to the lack of consideration of the personal characteristics of IM users and the social context of IM communications such as the position power of the message sender. Gupta & Li (2008) called for understanding the effect of IM interruptions in the social context of the communication. They primarily focused on the objective performance of the main task, suggesting that IM messages sent from the supervisor have greater negative consequence on the quality of the main task performed by the message receiver than those from the co-worker.

Our study responds to the call for examining the interruptive impact of IM within its social context, but focuses on users' perception of overall task complexity and their satisfaction with the multitasking work process. We posit that the position power of a message sender may influence the multitasking priority of message recipients and further adjust their cognitive perception of the task complexity. At the same time, drawing upon theoretical perspectives from social psychology (Bluedorn *et al*., 1999; Frei *et al*., 1999; Kaufman-Scarborough & Lindquist, 1999) and organizational behavior (Slocombe & Bluedorn, 1999; Conte & Jacobs, 2003; Conte & Gintoft, 2005; Hecht & Allen, 2005), the present study further extends this body of research by incorporating polychronicity, one type of personal characteristic, into task perception and satisfaction in organization communications. Polychronicity reflects an individual's time management orientation and is the individual's preference to switch among multiple tasks within the same time period (Bluedorn *et al*., 1999). It is contrasted with monochronicity, a preference for focusing on only one thing at a time. Neo & Skoric (2009) called attention to the importance of polychronicity in examining IM communication although their study did not find a significant relationship between polychronicity and students' preference for social interactions over IM. In this study, we believe that the introduction of polychronicity has clear relevance to understanding the impact of IM, given the nature of multitasking work environment employing IM as a supplementary means of communication. This study also provides insights to practitioners in organizations deploying IM technology. We suggest that understanding process satisfaction provides pragmatic insights into whether employees will accept IM technology in a voluntary setting and, perhaps more importantly, help management decide whether and how to deploy IM successfully in the workplace to increase employee satisfaction.

This paper reports on an empirical study that aimed to reveal how IM influences users' perceived task complexity and satisfaction about the multitasking work process. Synthesizing relevant prior research, we postulate that polychronicity, together with the interruptions and position power of message senders, influences message recipients' perceived task complexity and satisfaction. Our approach breaks new ground for IM research because it takes into account the interruptive nature of IM, personal factors, and social network characteristics. Three key research questions drove this study: (1) How do interruptions from IM influence users' perceived task complexity and satisfaction? (2) How does polychronicity of IM users influence their perceived task complexity and satisfaction? (3) How does polychronicity moderate the impact of the position power of message senders and interruptions on IM users' perceived task complexity or satisfaction?

The remainder of the paper is organized as follows. We first review the literature and propose our research model and hypotheses underlying the model. Then we describe our experiment, followed by a discussion of the findings of this study. Next, we present implications for theory and practice derived from these results. The paper concludes with the limitations of the study and guidance for future research.

Time, complexity and satisfaction in multitasking settings

The deployment of IM engenders a multitasking work environment. Knowledge workers often perform some main or primary tasks while responding to IM interruption messages. An individual's multitasking preference (i.e., polychronicity *vs* monochronicity) is expected to play a role in shaping his or her task perceptions and satisfaction with the multitasking work process. In addition, IM technologies incorporate

built-in awareness features that often contribute to higher expectations that recipients will respond immediately, which may increase the interruptive nature of IM. To achieve a better understanding of the impact of IM on users' perceived task complexity and satisfaction with the multitasking work process, it is necessary to integrate the literature of interruption and polychronic communication. In the following subsections, we will first discuss the subjective task complexity and process satisfaction as the dependent variables of our model. Then, we will give an overview of the theoretical foundations of interruption and polychronic communication and elaborate the impact of interruptions and polychronicity on subjective task complexity and user satisfaction with the multitasking work process and their potential interactions considering the position power of message senders.

Subjective task complexity

Task complexity has been examined from two perspectives, objective task complexity and subjective task complexity. In this study, we examine subjective task complexity as one of the dependent variables. Subjective task complexity is the level of task complexity perceived by employees. Instead of examining objective task complexity directly, we use subjective task complexity as a proxy for objective task complexity as subjective task complexity reflects objective task complexity. Moreover, to a certain extent, task complexity is a concept relative to the cognitive processing capacity of specific individuals. There is no completely objective measure for how complex a task might be. In fact, subjective task complexity is often used as a manipulation check for objective task complexity in experimental studies (Kernan *et al*., 1994; Maynard & Hakel, 1997). In addition, recent studies also suggest that subjective task complexity could exert additional influence on task performance beyond that of objective task complexity, and the effect of objective task complexity is partially mediated through subjective task complexity (Maynard & Hakel, 1997). Therefore, it is important to examine subjective task complexity as a focal variable. In this study, we examine how interruptions and polychronic communication influence subjective task complexity and how subjective task complexity further influences user satisfaction. A task could be made more complex by adjusting objective task features such as increasing the amount and/or diversity of information processed (Earley, 1985). IM messages increase the volume of information available to knowledge workers. IM interruptions are expected to play a role in influencing IM users' subjective task complexity. Besides objective task features, the perceived level of task complexity was also found to be influenced by individual characteristics such as previous task experience and personal task motivation, etc. (Maynard & Hakel, 1997).

Process satisfaction

Process satisfaction is one type of user satisfaction and defined as users' satisfaction with the multitasking work process in this study. User satisfaction is an important determinant of users' usage of information system and system performance (Gelderman, 1998). To attain a better understanding of how advanced information technologies that organizations use in social interaction trigger satisfaction amid their resources (i.e., employees), we hereby refer to Adaptive Structuration Theory (AST) to describe the process by which people incorporate advanced technologies into their work practices. Once applied, technologies should trigger structural change in terms of productivity, efficiency, and satisfaction to individuals and organizations (DeSanctis & Poole, 1994). As group outcomes reflect the manner in which groups appropriate the structures of the technology and the context of its use, AST indicates that the structural change can be captured in interpersonal interaction at micro, global, and institutional levels. In essence, AST posits that when technologies are enacted or appropriated, there is always the possibility that social structures will change in organizations. Then, at the individual level, organizational users may change their awareness, knowledge, power, motivations, circumstances, and satisfaction. In an AST context, the use of group-wise systems such as IM can be depicted as an input-process-output process where the technological appropriation may lead to users' satisfaction with outcome and process (Gopal *et al*., 1993).

Furthermore, process satisfaction has been found to be influenced by tasks characteristics and medium types. For example, Suh (1999) investigated the effect of two types of tasks (intellective tasks *vs* negotiation tasks) and four different communication media (text, audio, video, and face-to-face). Intellective tasks involve solving problems to which there exists a single obviously correct answer whereas negotiation tasks do not have such single correct solution. He found that process satisfaction was higher for intellective tasks than for negotiation tasks and that face-to-face communication yielded higher level of process satisfaction than other communication medium types. In this study, we examine how process satisfaction is influenced by the frequency of interruption (one type of objective characteristics of interruptive IM tasks), subjective task complexity and a person's multitasking orientation (i.e., polychronicity).

Interruptions

Though interruptions have been defined in several different ways (see Corragio, 1990, p. 19; Jett & George, 2003; Speier *et al*., 2003, p. 772), for the purpose of this study, interruptions are defined as incidents or occurrences that impede or delay organizational members' progress on work tasks (Jett & George, 2003). The timing of an interruption is usually random and beyond the control of a recipient. It breaks the attention of the message recipient and typically requires immediate

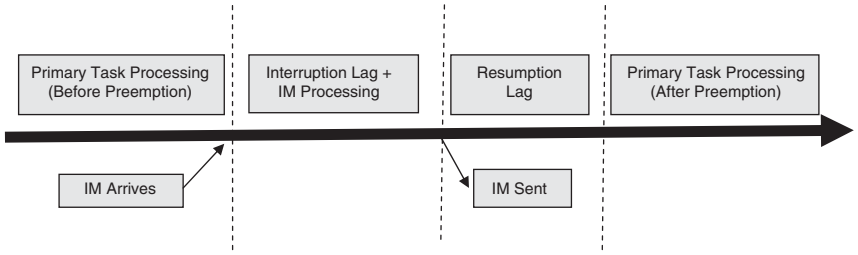

Figure 1 The process of interruption (Trafton *et al.*, 2003).

switching from the main task to the interruption task. Main tasks and interruption tasks compete for the limited cognitive processing resources of an individual. Interruptions could change knowledge workers' task priority and the way in which they process information and make decisions.

Figure 1 describes the process of interruption. When an IM message arrives, a worker must switch from a current work medium to the IM medium. This switching time, is usually small and is a non-value added, is often referred to as interruption lag (Trafton *et al.*, 2003). After processing the IM request, the worker has to spend extra non-value added time to restart a task due to re-immersion. The recovery time due to interruptions caused by IM is referred to as resumption lag (Trafton *et al.*, 2003) or penalty. Although unknown for an IM interruption, this penalty has been reported to be about 64 s per email interruption (Jackson *et al.*, 2001, 2003). According to these findings, although this time frame may appear to be small but the cumulative interruption and resumption lags may become significant due to the large number of messages arriving on a daily basis. These lags have the potential to increase the non-value-added time of a knowledge worker, decrease the knowledge worker's time-effectiveness, and potentially increase the time needed to complete the primary task. A recent study conducted by Gupta & Sharda (2008) revealed that a knowledge worker may lose 4–5% of their workday due to interruptions from arriving messages. As such, a knowledge worker may lose on an average 28 min out of a 10-h workday. When an IM message arrives, the knowledge worker is preempted from a primary task. After spending a small switching time, the worker starts to process the IM request. Once the processing on the IM is over, workers spend a small recall time (RL) before they can resume their previously interrupted task.

The effect of interruptions has been examined from multiple dimensions in previous studies. Speier *et al.* (1999) investigated the effect of frequency and content relevancy of interruptions on task performance. They found that interruptions facilitate performance on simple tasks and decrease performance on complex tasks. The negative impact of interruptions on complex tasks was more severe when the content of the interruption was dissimilar to the primary task. Beyond the body of prior investigations, our study focused on the frequency and social characteristics of interruptions. We compared the effects of low interruption frequency with high interruption frequency on perceived task complexity and user satisfaction. For social characteristics of the interruption, we examined the effect of position power of senders on perceived task complexity. Speier *et al.* (1999) suggested that social characteristics of an interrupter, such as his or her status or position power may influence the way the interruption message is processed (and responded to). For example, message recipients are likely to give a higher priority to messages from a supervisor than from co-workers or peers (Gross *et al.*, 2006). As a result, they could spend less effort and process fewer information cues in the main task. Since few studies have examined the interruptions from a social perspective, we posit that the effect of interruptions should be investigated in the context of social ties between message sender and recipient. The position power of message sender may interact with the effect of interruptions on the way tasks are processed and perceived. Interruption messages generated by a supervisor may have different impact on receivers' perceived task complexity from messages by a peer or co-worker.

Polychronicity

Time has long been considered as a fundamental concept in explaining organizational behaviors (Cummings & Staw, 1995). Recently, polychronicity, as an individual's time management orientation, is gaining growing research attention. Polychronicity was originally introduced by Hall (1959) as a cultural-level construct, reflecting organizational members' shared preference for time-use. Employees in an organization may share a common polychronic culture. Unlike monochronic cultures, polychronic cultures spend more time socializing and are less concerned with deadlines, structure, and time (Hall, 1983). Individuals in polychronic culture were found to be less concerned with download delay of websites than those from monochronic culture (Rose *et al.*, 2003). Since the 1990s, polychronicity has also been examined as an individual-level variable (Kaufman-Scarborough & Lindquist, 1999; Slocombe & Bluedorn, 1999). At individual level, polychronicity is proposed to be an individual difference personality characteristic (Conte & Gintoft, 2005). Individuals could be classified, based on the level of polychronicity, along a

continuum from very monochronic to very polychronic (Slocombe & Bluedorn, 1999; Conte & Jacobs, 2003). Monochronic individuals prefer to work on one activity in the same time block while polychronic individuals prefer to work on multiple activities over the same period of time (Kaufman-Scarborough & Lindquist, 1999).

Individual polychronic time-use may take two forms. One form is to perform multiple tasks simultaneously (Ofori-Dankwa & Julian, 2001). Simultaneous multitasking is more amenable for tasks using different sensory modalities or body parts than those using the same sensory modalities (Pashler, 1998). For example, it is easier for a knowledge worker to read an IM message and listen to a phone call than to read both the IM message and a business report at the same time. The second form involves switching between tasks over a period of time (Bluedorn *et al*., 1999), such as writing a report while responding to IM messages. Prior studies on polychronicity are largely oriented toward the task-switching form of time-use (Bluedorn *et al*., 1999; Arndt *et al*., 2006). In this study, we followed the main body of studies on polychroncity and examined polychronicity as an individual's tendency to switch among multiple tasks.

Individual-level polychronicity has been linked to a number of work and non-work activities. For example, polychronicity has been found to be negatively related to preferences for following schedules and deadlines (Benabou, 1999) and positively related to absence (Conte & Jacobs, 2003). Here, although polychronic individuals are less preferred to follow schedules and deadlines than monochronic individuals, it does not suggest that all or most of their tasks are not done on time. At the same time, polychronicity is positively correlated with creativity (Bluedorn *et al*, 1999). Polychronic individuals also treat interpersonal relations as important as the work to be performed while monochronic individuals are suggested to devote more to one particular task than to interpersonal communication (Benabou, 1999). Hall & Hall (1990) also suggested that polychronicity involves the ability to handle interruptions. For polychronic individuals, time is not considered as a tangible resource and timely completion of tasks is not a major concern for them. Previous studies have also examined the effect of polychronicity on job performance with inconsistent results (Conte & Gintoft, 2005; Hecht & Allen, 2005; Konig *et al*., 2005). For example, in a task context emphasizing punctuality, schedules, and deadlines, such as the train operator job, polychronic employees received lower supervisory ratings of their performance. In a multitasking retail environment, polychronic salespersons received higher subjective ratings of sales performance from their supervisors (Conte & Gintoft, 2005). However, polychronicity was insignificant for predicting objective multitasking performance based on the correctness and speed of answers (Konig *et al*., 2005). In general, polychronicity is not considered to be a good predictor of task performance (Hecht & Allen, 2005). 'Polychronicity is about how work is done, not about how much work is done' (Slocombe & Bluedorn, 1999, p. 77). Polychronic individuals do not necessarily work any faster than monochronic ones (Hecht & Allen, 2005). Therefore, polychronicity, as a personal trait, primarily determines how time is allocated to multiple tasks rather than how quickly those tasks are done. For this reason, we will examine the effect of polychronicity on IM users' task perceptions and satisfaction instead of the effect on actual task performance. The following subsection presents our research model and theoretical underpinning of each of the hypotheses.

Hypotheses

Drawing upon interruption and polychronic communication (i.e., polychronic/monochronic) literatures, our research model (Figure 2) depicts how the interruptive features of IM communication may intertwine with polychronicity and jointly influence users' perception of task complexity and satisfaction with the multitasking work process. Specifically, the study proposes that (1) perceived task complexity increases with interruption frequency but decreases for monochronic employees receiving IM interruptive messages from their supervisors, and (2) process satisfaction increases with employees' polychronic orientation but decreases for monochronic employees facing increasing level of interruption frequency.

Direct effects of interruption frequency Prior studies have suggested that a task could be made more complex by increasing the *number* of information cues and/or the *diversity* of information processed (Earley, 1985). Simple tasks require processing fewer cues than complex tasks.

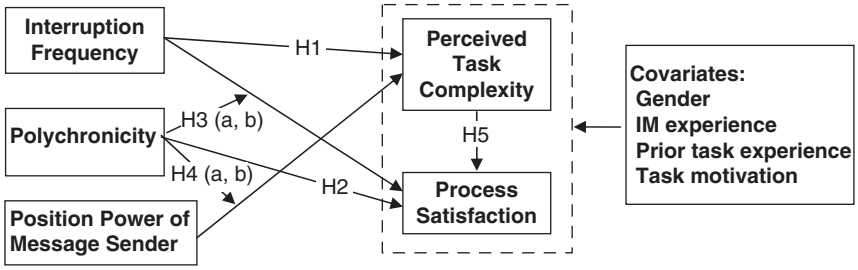

Figure 2 Research model.

In a context of IM communication, more frequent IM interruptions increase the number of information cues to be processed by knowledge workers and are very likely to increase their subjective task complexity. Perceived overall task complexity could further increase in a multitasking work environment involving both IM tasks and primary tasks. IM interruptive tasks diversify the information processed, requiring additional processing effort for switching between tasks. Therefore,

H1: *Interruption frequency has a positive impact on perceived task complexity.*

Effects of polychronicity and interruption frequency Polychronicity refers to an individual's tendency to be involved in two or more tasks simultaneously (Conte & Gintoft, 2005). Polychronicity is a fairly stable personal trait (Turner *et al*., 2006). Individuals with low polychronicity prefer to complete one task at one time, whereas those with high polychronicity prefer to do several tasks simultaneously. The literature on polychronicity emphasizes the fit between an individual's polychronic orientation and task. Monochronic individuals may become disoriented in a multitasking work environment and were found to be more bothered by interruptions than polychronic individuals (Frei *et al*., 1999). The congruence between polychronic orientation and task setting could increase the perceived fairness of the work process and, therefore, enhances the knowledge workers' satisfaction with the work process.

The deployment of IM in the workplace engenders a multitasking work environment. 'A majority of IM users say they do other things on their computer and online at the same time they are participating in IM sessions. 32% adult IM users report that they multitask all the time; 29% admit they do this some of the time' (Shiu & Lenhart, 2004). Those individuals with a low polychronic orientation will have a hard time switching between tasks and will be less satisfied with using IM while performing a main task. Therefore,

H2: *Polychronic individuals are more satisfied with multitasking work process than monochronic individuals.*

Beyond the direct effect of polychronicity, using the concept of task employee fit, we also propose that polychronic orientation moderates the effect of interruptions on the two dependent variables. Monochronic individuals prefer to concentrate on one activity at a time and view multitasking as fragmented, confusing, stressful, and lacking focus (Conte *et al*., 1999). The increase in interruption frequency of IM messages is expected to reduce their satisfaction with the work process. Conversely, polychronic individuals prefer to switch between tasks and perceive polychronic behavior as efficient and motivating (Conte *et al*., 1999). They feel satisfied in a multitasking environment such as the one with interruptions. However, no studies have examined how interruption frequency may influence their satisfaction with the work process. Clearly, under extremely high level of interruptions far beyond an individual's mental processing capacity, a polychronic individual also expects to suffer reduced satisfaction with the workplace process. The effect of extremely high level of interruptions is beyond the scope of this study. In this study, we choose to examine low *vs* relatively high level of interruption frequency as typically observed in a regular work setting. At a low to relatively high level of interruption frequency, a polychronic individual expects to achieve or sustain an overall high level of process satisfaction. The increase in interruption frequency from low level to relatively high level may have little enhancement effect on the overall high level of process satisfaction. Therefore,

H3a: *Polychronicity moderates the relationship between interruption frequency and users' satisfaction with multitasking work process such that, for monochronic individuals, interruption frequency has a negative impact on users' satisfaction with multitasking work process.*

H3b: *Polychronicity moderates the relationship between interruption frequency and users' satisfaction with multitasking work process such that, for polychronic individuals, interruption frequency has no impact on users' satisfaction with multitasking work process.*

Effects of polychronicity and position power of message sender Besides interruption frequency, we also examined the effect of polychronicity and the position power of message senders, as one type of social characteristics of interruptions, on subjective task complexity. It is necessary to consider the social context of the multitasking work process, which could potentially determine the processing strategies adopted by monochronic and polychronic individuals. In the literature of polychronic communication, monochronic individuals 'lean more toward strict planning, time allocation, and *prioritizing* in attempting to meet their obligations' (Kaufman-Scarborough & Lindquist, 1999, p. 289). When monochronic individuals are under the time pressure to process interruption messages from their supervisors, they are expected to prioritize tasks and give a higher priority to IM tasks to meet their immediate obligations to their supervisor. As a result, when message senders are their supervisors, monochronic individuals may use a heuristic approach to work on the main tasks or process fewer information cues of the main tasks. The heuristic processing of the main task is likely to cause monochronic individuals to perceive the overall task to be less complex. In other words, interruptive IM messages from supervisors may reduce the overall task complexity perceived by monochronic individuals. On the other hand, to the extent that interruptions from peers would not be given a priority as high as those from supervisors (Gross *et al*., 2006), message receivers are less likely to use

a heuristic approach to process the main task. The completion of both the main task and interruption tasks in full attention is likely to drain their mental capability and increase their perceived task complexity.

In contrast, polychronic individuals do *not* view time as a tangible resource (Slocombe & Bluedorn, 1999) and are less concerned about deadlines (Hall, 1983). Therefore, they are less pressured to prioritize tasks. They attempt to seek a balance between multiple tasks. The interruption messages from peer and supervisor are very likely to be handled in a similar way. Hence, position power has no or weak impact on task complexity when message receivers have high polychronicity. Therefore,

H4a: *Polychronicity moderates the relationship between position power and perceived task complexity such that, for monochronic individuals, position power of message senders reduces perceived task complexity.*

H4b: *Polychronicity moderates the relationship between position power and perceived task complexity such that, for polychronic individuals, position power of message sender has no impact on perceived task complexity.*

Perceived task complexity and process satisfaction In this study, we are interested in process satisfaction, which reflects users' satisfaction with the working process deploying IM (i.e., responding to IM interruptions while working on a main task). According to Suh (1999, p. 302), 'efficient and effective processes will result in higher process satisfaction'. The interruptions of IM messages incur additional switching time that is not productive. When tasks are perceived to be complex, more information cues and/or interrelationships among cues would need to be recalled for switching between IM tasks and the main tasks. As a result, longer non-productive switching time is needed to process complex tasks, which reduce the efficiency and effectiveness of the work process and, therefore, may lower knowledge workers' satisfaction with the interruptive working process using IM. So we hypothesize that

H5: *Perceived task complexity reduces users' satisfaction with multitasking work process.*

Covariates

Besides the above independent variables, the research model consists of four control variables: gender, IM experience, prior task experiences, and task motivation. Gender has been found to influence polychronic tendency with females being more polychronic than males (Manrai & Manrai, 1995). Gender may directly influence an individual's information processing strategy and his/her perceived task complexity. Further, prior experience with the technology, that is, IM, may influence an individual's process satisfaction and perceived task complexity. More experience with IM may improve an individual's process satisfaction and reduce his or her perceived task complexity. Also, an individual's task experience and motivation to perform the task is likely to influence his or her perceived task complexity. Maynard & Hakel (1997) suggest that higher levels of task motivation and task experience were significantly associated with higher levels of subjective task complexity. These four variables were controlled for both dependent variables.

Research method

Study design and procedures

An experimental design was deployed to manipulate the two characteristics of interruptions: interruption frequency and position power of the message sender. In contrast with the study by Speier *et al*. (1999), task similarity was not manipulated in our study. The main task and interruptive tasks (i.e., IM tasks) were dissimilar with the degree of dissimilarity being the same or controlled for all subjects. Interruption frequency was manipulated at two levels: low interruption and high interruption. Subjects received one IM message at low interruption level and four IM messages at high interruption level. Mark (2006) reports that one interruption every three minutes is a high level of task interruption. In our experiment, the total task time (i.e., primary task time + interruptive IM task time) of subjects in the high interruption group averaged 14 min (with 23 min as the maximum length). Four interruptions in 14 min equate to one interruption every three and half minutes, which is comparable to the high level of interruptions reported by Mark (2006) . In the Data Analysis section below, the result of the manipulation check on interruption level also statistically verified that the high interruption level differed from and exerted greater impact than the low interruption level. The position power of message sender was manipulated at two levels: peer and supervisor. Thus, these two manipulated variables jointly form four treatment conditions.

Subjects were randomly assigned to only one of four treatment conditions. A printed task page was used to introduce the task scenario to subjects and provide detailed step-by-step instructions. Each subject assumed the role of a knowledge worker working on a group project that aimed to improve the supply chain of a company. The subject was instructed to work on a main task and, at the same time, be ready to respond to IM messages sent from his or her project member (peer) or project manager (supervisor) depending on which group he/she was assigned to. The main task and interruptive IM tasks are dissimilar. The main task was to browse the websites of UPS and U.S. Postal Service and search for shipping costs of two different packages to a warehouse (Appendix A). So each subject was asked to search for four shipping costs. When subjects were performing the search tasks, they were interrupted by IM messages.

The IM application used in this study is Yahoo! Messenger, which allows the researcher to send a message to multiple recipients at the same time. All interruption messages were sent out by researchers. Each subject was involved in dyadic communication (i.e., only interacting with the imaginary peer or supervisor). The IM messages requested the subjects to compare eight suppliers based on account payable term, delivery time, or product costs. The information of the eight suppliers was provided in a printed table adopted from Laudon & Laudon (2007) (Appendix B). Subjects were instructed to respond to IM messages once they received them. Appendix C shows the questions that were sent through IM to interrupt the subjects. Each interruptive IM task took an average of 36 s to be completed with a standard deviation of 31 s. The design of IM task is consistent with the typical usage profile of IM (i.e., used for short, simple, and quick communications) identified by previous studies (Cameron & Webster, 2005; Hung *et al*., 2008). After searching for the shipping costs and entering the results in an EXCEL worksheet, subjects were required to fill out an online survey. No time constraints were imposed on the time spent in searching for shipping costs.

Data collection

Student volunteers at a major northern U.S. university were used as the subjects for our lab experiment. They were recruited from core business classes required for students in their junior or senior years. All subjects were volunteers and received less than 1% extra credit for participation. In all, 112 usable responses (50 females and 62 males) were included in our final data analysis. The age of the subjects ranges from 19 to 39 years with an average age of 23 years and standard deviation of 0.32. There are 26 responses in each of the two treatment conditions using peers as message senders (i.e., low interruption and peer, high interruption and peer) and 30 responses in each of the two treatment conditions using supervisors as message senders (i.e., low interruption and supervisor, high interruption and supervisor).

Variable measurement

All latent constructs in the research model were measured using existing validated scales (Appendix D). Some items were slightly adapted to reflect the research context. Perceived task complexity and task motivation were measured using the instruments by Maynard & Hakel (1997). Polychronicity orientation was measured using the scales by Conte & Jacobs (2003). Process satisfaction was modified from the instruments by Green & Taber (1980). Perceived work overload was adapted from the instruments by Moore (2000), which was used to check the manipulation on interruption. A single question ('Mr. Smith' that I just interacted with has higher position power than I have) was developed to check whether the manipulation on the position power of message senders was successful. All these items were measured on a five-point Likert scale with 1 being strongly disagree and 5 being strongly agree. Gender, IM experience, and prior task experience were each measured using a single item scale. Gender was measured by 'What is your gender' (male/female). IM experience was measured in years by 'Approximately how long have you been using Instant Messenger?' Prior task experience was measured by 'How much experience have you had in the past with supply chain related tasks similar to those that you have just worked on?' on a scale from none, a little, some to a lot.

Data analysis

Partial least squares (PLS) technique was performed to test the measurement model and research hypotheses. PLS requires a smaller sample size than other SEM techniques (Chin *et al*., 2003). The minimum sample size required by PLS is 10 times the larger number of paths leading to an endogenous construct when all constructs are reflective. In our research model, the maximum number of paths entering an endogenous variable is eight including the four control variables and two interaction variables between interruption and polychronicity and between position power of the message sender and polychronicity. Therefore, a sample size of 112 is deemed to be sufficient for PLS analysis. Moreover, PLS does not assume a multivariate normal distribution and interval scales (Wold, 1982). Our model consists of two binary manipulated variables. As such, PLS is considered more appropriate for our study than other SEM techniques.

Measurement model and manipulation check

We examined convergent validity, reliability and discriminant validity of all latent constructs before testing the hypotheses. Convergent validity is suggested if item loadings are 0.60 or higher (Bagozzi & Yi, 1988). All indicators had loadings above 0.6 except two items used to measure polychronicity and two of the items used to measure perceived work overload. These four items were then dropped before the following analysis. All remaining measurement items were found to load significantly on their respective latent constructs. All these confirm the convergent validity of the measurement model. A scale is considered reliable if its composite reliability (CR) is above 0.7 and average variance extracted (AVE) is above 0.5 (Bagozzi & Yi, 1988). From Table 1, all scales used in our study satisfy the above criteria for reliability. Two criteria were further used to assess discriminant validity based on loading and cross-loading matrix (Table 2) and correlation matrix (Table 1). All measurement items should load more strongly on their respective construct than on other constructs. Second, the square root of AVE of each construct should be higher than the inter-construct correlations, that is, the correlations between that construct and any other constructs (Fornell & Larcker, 1981). As shown in Tables 1 and 2, all constructs in our model

Table 1 Correlation matrix, reliability (CR) and average variance extracted (AVE) of latent constructs

Constructs	*Mean (STD)*	*Reliability*	*AVE*	*1*	*2*	*3*	*4*	*5*
1. Complexity	2.6 (0.9)	0.94	0.79	**0.89**				
2. Satisfaction	3.8 (0.7)	0.91	0.68	−0.18	**0.82**			
3. Polychronicity	3.2 (0.7)	0.89	0.59	0.21	0.41	**0.77**		
4. Motivation	3.5 (0.7)	0.87	0.68	0.34	0.32	0.37	**0.83**	
5. Workload	3.2 (0.9)	0.86	0.93	0.40	−0.23	−0.10	0.12	**0.96**

Note: Diagonal elements are the square root of the AVE values. Off-diagonal elements are the correlations among latent constructs.

Table 2 Results of factor analysis on latent constructs

Constructs/items	*Loadings and cross loadings*				
	1	*2*	*3*	*4*	*5*
1. Complexity					
COMP1	**0.78**	−0.13	0.17	0.13	0.28
COMP2	**0.91**	−0.24	0.13	0.29	0.40
COMP3	**0.94**	−0.17	0.19	0.38	0.41
COMP4	**0.91**	−0.10	0.26	0.34	0.31
2. Satisfaction					
SATP1	−0.09	**0.85**	0.39	0.27	−0.18
SATP2	−0.14	**0.84**	0.33	0.26	−0.23
SATP3	−0.22	**0.85**	0.27	0.22	−0.18
SATP4	−0.12	**0.66**	0.17	0.27	−0.10
SATP5	−0.19	**0.89**	0.47	0.30	−0.24
3. Polychronicity					
POLY1	0.06	0.38	**0.77**	0.32	−0.16
POLY3	0.27	0.19	**0.81**	0.24	−0.08
POLY4	0.15	0.40	**0.83**	0.24	−0.06
POLY6	0.22	0.34	**0.84**	0.41	−0.02
4. Motivation					
MOTI1	0.28	0.15	0.29	**0.83**	0.11
MOTI2	0.30	0.34	0.35	**0.85**	0.11
MOTI3	0.27	0.26	0.27	**0.80**	0.08
5. Workload					
LOAD1	0.40	−0.24	−0.11	0.11	**0.97**
LOAD2	0.38	−0.20	−0.07	0.12	**0.96**

Note: All bold loadings are significant with a *P*-value < 0.001.

satisfy these two criteria for discriminant validity. Therefore, our measurement model demonstrates sound reliability and validity and should warrant the further analysis on our research hypotheses.

Two *t*-tests were conducted to check the manipulation on the position power of message senders (peer *vs* supervisor) and interruption frequency (low *vs* high). The position power of message senders in the subordinate-to-supervisor condition was perceived to be significantly higher than that in the peer-to-peer condition with a *P*-value <0.01. Perceived workload in the high interruption group was also found to be significantly higher than that of the low interruption group (*P*-value <0.05). Therefore, the manipulation of both the position power of the message sender and interruption frequency was successful.

Results of hypotheses testing

Figure 3 and Table 3 summarize the results of testing the hypotheses. The model could explain 24.2% of the variance in the perceived task complexity and 40.7% of the variance in process satisfaction.

We first analyzed the moderation effects of the polychronicity for Hypotheses 3 and 4. Then we tested other main effect hypotheses. To analyze interaction effect, we applied the product-indicator approach suggested by Chin *et al*. (2003). Let X and Z be the predictor and moderator. For example, in Hypothesis 4, X would be the position power of message sender and Z be polychronicity. The indicators in X and Z were first centered. Then, the indicators of the interaction term ($X \times Z$) was established by multiplying the indicators from X and Z, that is, consisting of all possible cross-multiplications of indicators in X and Z. Once interaction terms were formed, PLS analysis was performed by including X, Z and $X \times Z$. Following the procedures by Chin *et al*. (2003), we examined both effect size and statistical signification of the moderation effect. The effect size (f^2) was 0.06 for the interaction between polychronicity and interruption frequency and 0.07 for the interaction between polychronicity and the position power of message sender. Both of the effect size values satisfies the 0.02 cutoff for small effect size (Cohen, 1988)[1] and are found to be statistically significant ($P<0.05$). Therefore, polychronicity moderates the effect of interruption frequency on process satisfaction and the effect of position power of message sender on perceived task complexity. The interaction patterns of the two moderation effects are show in Figures 4 and 5. Both patterns are consistent with the hypotheses. The utility by Preacher *et al*. (2006) was then applied to test statistical significance of different level of polychronicity. We found that, for knowledge workers with low polychronicity (1 standard deviation below the mean), the increase in interruption frequency reduces their process satisfaction and the position power of message senders significantly reduces their perceived task complexity. For knowledge

[1] f^2 = [R^2 (interaction model) − R^2 (main effects model)]/[1−R^2 (main effects model)].

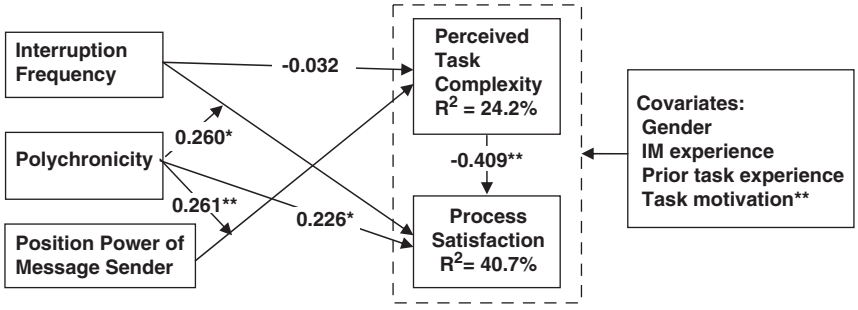

Figure 3 Results of testing hypotheses using PLS analysis. Completely standardized estimates, controlled for covariates in the research model, *$P<0.05$, **$P<0.01$ (two-tailed).

Table 3 Summary of hypothesis testing results

Hypotheses	*Path coefficients*	*t Value*	*P value*
H1: Interruption Frequency → Perceived Task Complexity.	−0.032	0.38	$P>0.05$ (not supported)
H2: Polychronicity → Process Satisfaction	0.226	2.08	$P<0.05$ (supported)
H3: Polychronicity × Interruption Frequency → Process Satisfaction	0.260	2.49	$P<0.05$ (supported)
H4: Polychronicity × Position Power of Message Sender → Perceived Task Complexity	0.261	2.84	$P<0.01$ (supported)
H5: Perceived Task Complexity → Process Satisfaction	−0.409	4.65	$P<0.01$ (supported)

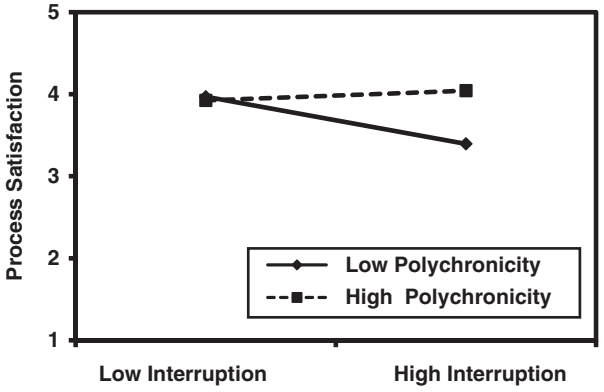

Figure 4 The moderation effect of polychronicity on the relationship between interruption frequency and process satisfaction.

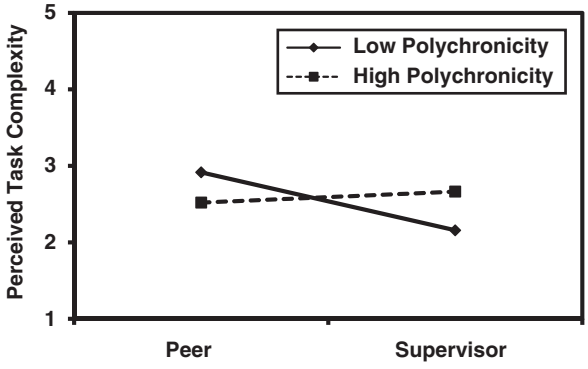

Figure 5 The moderation effect of polychronicity on the relationship between the position power of message sender and perceived task complexity.

workers with high polychronicity (1 standard deviation above the mean), interruption frequency has no significant effect on process satisfaction and position power of message senders has no significant effect on perceived task complexity. Therefore, H3 and H4 were supported.

The remaining hypotheses were all found to be statistically significant except H1. Interruption frequency was not found to significantly influence the perceived task complexity. Overall, the research model is well supported. In addition, among the four covariates, task motivation was found to significantly increase perceived task complexity and process satisfaction (P-value <0.01).

Discussion

Summary of findings, *post-hoc* analysis, and limitations

In addressing the research questions, this study has discovered several intriguing findings that provide fruitful avenues for IM-related research. The results of our study suggest that an individual's time management

orientation (i.e., polychronicity) influences his or her satisfaction with the work process. Polychronic individuals were found to be more satisfied with the work process deploying interruptive IM technology than those with low polychronicity. Further, polychronicity moderates the effect of interruption dimensions on an individual's perceived task complexity and process satisfaction. In particular, we examined two dimensions of interruptions: frequency and position power of message senders. Interestingly, we found the important role of position power of message senders and individuals' polychronic orientation. For monochronic individuals, the increase in IM interruption frequency significantly reduces their satisfaction with the work process. In terms of the position power of the message sender, the results suggest that monochronic individuals tend to prioritize tasks and perceive a lower level of overall task complexity (considering both the main task and interruptive IM tasks) when interruptive IM messages are sent from their supervisors. Monochronic individuals view time as a tangible resource and are more likely to feel the time pressure to instantaneously respond to IM messages sent from their supervisor than polychronic individuals. As a result, they may adopt a heuristic strategy to process the main task (i.e., skip processing some information cues) and perceive a lower level of overall task complexity. For polychronic individuals, on the other hand, the two dimensions of interruptions have little impact on process satisfaction and perceived task complexity due to their inherent multitasking preference and time management orientation (i.e. viewing time as intangible (Slocombe & Bluedorn, 1999)).

The findings support all hypotheses except H1. Interruption frequency has no significant impact on perceived task complexity. This may be related to the relatively low overall perceived complexity level of tasks used in this study. As shown in Table 1, the average perceived task complexity is 2.6. Under relatively low task complexity (including both the main task and interruptive IM tasks), the increase in interruption frequency may have little impact on the perceived task complexity.

Besides hypothesized relationships, we found that subjects who were motivated to perform the experimental tasks were more satisfied with the task process and perceived the task to be less complex (P-value <0.01). We further conducted a *post-hoc* analysis on the potential role of task motivation in moderating the relationship between interruption frequency and perceived task complexity, between polychronicity and process satisfaction and between interruption frequency and process satisfaction. None of the three interaction terms was significant (P-value <0.05). Therefore, task motivation only exerts direct impacts on perceived task complexity and process satisfaction.

Before we discuss the implications of our study, we point to some of its limitations. First, the study used student subjects, which restricts the external validity of the study to a certain extent. Future studies using knowledge workers in organizations will provide stronger support for our results. To alleviate the restrictions on external validity imposed by student subjects, the study controlled for subjects' task experience. In addition, the age range of the subjects of this study is 19–39 years, which is representative of the current users of IM at the workplace to a large extent. Recent studies have found that IM is used more often by younger employees (<35 years) in the workplace (Cho *et al.*, 2005; Kizer, 2008). Second, we tested our research model based on the main task with moderate mental processing. We should exercise caution when extending the results to task contexts with more or less complex tasks. Different task complexity levels may generate different outcomes. Future studies could further test our research model using more complex main tasks, such as idea generation tasks, which require intensive mental processing or memory. When polychronic individuals perform main tasks requiring intensive memory processing, their satisfaction with the work process may decrease with the increase in the interruption frequency. Third, task similarity between the main task and the interruptive task was not investigated in this experimental study, which was controlled to be the same for all subjects. Future studies could further extend our research model by manipulating task similarity at different levels from being similar to dissimilar. Fourth, this study did not examine the potential effect of job roles. IM interruptive tasks and main tasks could require knowledge workers to undertake different job roles such as switching from writing software to providing technical support service to clients over IM. The job demands from different roles at the same time may increase the chance for individuals to experience role overload, defined as 'having more role behaviors to do than can be done a given time period' (McGrath & Kelly, 1986, p. 112). On the other hand, the interruptive effect of IM messages may be reduced if IM tasks have the same job role as that of the main task. Future studies on IM interruptions may need to consider the effect of role overload. Finally, it is possible that one's preference for polychronicity or monochronicity may depend on the nature of the work task and the individual's level of mental agility at the time of the task completion, so future studies may test for variability in this individual-level attribute longitudinally.

Implications for research

This study has several important implications for research. First, our study found that a knowledge worker's satisfaction with the work process utilizing IM is influenced by the interaction between interruption frequency and the individual's multitasking preference (polychronicity). Studies ignoring the moderation effect of polychronicity will provide incomplete results. Further studies are necessary to study the direct and moderation effects of polychronicity on employee satisfaction with

the work process considering different levels of interruption frequency and objective tasks complexity.

Second, the results suggest that an individual's polychronic tendency also interacts with the position power of the message sender in determining his or her perceived task complexity. Monochronic individuals are more inclined to use scheduling and prioritizing tasks to meet their obligations when they are under time pressure. As a result, when prompted to respond to IM messages sent from their supervisors, monochronic individuals could perceive a lower overall task complexity through lowering the priority of main tasks and process fewer information cues. Therefore, monochronic and polychronic individuals not only differ in their preference of multitasking but also in their time management orientation. At present, the understanding of the effect of time management orientation of individuals in the workplace is limited. The difference in time management orientation, that is, polychronicity, may interact with the position power of the message sender and influence not only their perceived task complexity but also their task performance.

Finally, it is important to consider the effect of the position power when examining the potential consequence of IM interruptions. The findings of this study suggest that the position power of message senders plays a role in influencing the way in which message recipients, especially those with low polychronicity, process tasks, subsequently shaping their perceived task complexity. Besides the position power of message senders, other social characteristics of IM interruptions may also enable researchers to further understand the impact of IM technology. For example, the strength of the social ties between message senders and recipients could influence process satisfaction as well.

Implications for practice

The findings of this study also have important implications for organizations deploying IM technology. First, our study suggests that polychronic individuals tend to be more satisfied with the work setting with IM interruptions than monochronic individuals. Polychronic individuals are more likely to be committed to organizations in such a multitasking work environment. Organizations would need to consider an individual's polychronic orientation when assigning jobs and deploying IM technology such as fitting polychronic individuals into multitasking jobs with IM interruptions. Monochronic individuals may be allowed to turn off the presence awareness feature or post a 'do not disturb' or 'busy' indicator. The challenge of controlling the interruption frequency for monochronic knowledge workers is not so much at the implementation or the technology level as it is at the management or cultural level. The technology needed to control the interruption flow/arrival already exists at the server and client level. Any alterations in such settings, however, may require changes in the communication practices at workplace, and impression management (e.g., a knowledge responding to a message immediately upon receiving may leave a better impression on supervisor than a worker responding to a message received after 8 h). In the overall picture, implementing controlled interruption frequency would also require senior management and peers to develop a better understanding of how it impacts the overall communication culture of the organization.

Second, we found that the increase in interruption frequency quickly reduces monochronic individuals' process satisfaction. Yet the increase has little impact or only slightly enhances polychronic individuals' process satisfaction. Organizations would be advised to consider such polychronic differences when monitoring and controlling the frequency of IM interruptions. IM interruption frequency should be kept minimum for monochronic individuals and be at low to relatively high level (not extremely high) for polychronic individuals.

Third, a fit between employees' polychronic orientation and work setting helps to increase their satisfaction. Employee satisfaction resulting from polychronicity/job fit was found to further reduce employee turnover (Arndt *et al*., 2006). Organizations should consider such fit in their hiring decisions. The Inventory of Polychronic Values (IPV) developed by Bluedorn *et al*. (1999) or a scale similar to IPV has been recommended to organizations to classify workers along the monochronic/polychronic continuum (Arndt *et al*., 2006). Alternatively, a worker's polychronic orientation could also be revealed through an in-depth interview on his or her liking or disliking of tasks conducted in the previous employment (Barclay, 2001). Organizations can then identify those with a relative high level of polychronicity for multitasking environments, while hiring those more oriented toward the monochronic end of the continuum for tasks emphasizing strict schedules.

The fit between task and polychronic orientation also has important implications for the job design. Organizational tasks could be classified based on time dimensions such as deadlines and punctuality (i.e., the degree of rigidity to which deadlines are adhered) (Schriber & Gutek, 1987). Such time dimensions could then be considered to facilitate job coordination and synchronization among employees with varying degree of polychronic orientation (Schriber & Gutek, 1987; Benabou, 1999). For organizational units dominated by monochronic employees, message senders could be required to send tasks with flexible deadlines and less stringent punctuality through asynchronous communication channels instead of the synchronous IM systems. In this way, unnecessary interruptions could be avoided, which helps increase the job satisfaction of monochronic message receivers. Technologies could also be designed to continuously monitor the level of interruptions received by each employee from all electronic communication channels and divert incoming interruptive tasks requiring no immediate responses to asynchronous channels when necessary.

Fourth, monochronic and polychronic individuals take different approaches in managing their time. Such differences in time management have an impact on how the job is done. Monochronic individuals are likely to give lower priority to the main task and, therefore, process fewer information cues in the main task when they are under the time pressure to respond to interruptive IM messages from their supervisors. Conversely, as polychronic individuals view time as intangible (Slocombe & Bluedorn, 1999), they would try to seek a balance between the main task and IM interruption tasks. These two time management orientations should be recognized and considered in the job design of an organization.

Last, when deploying IM technology, organizations should consider the position power of the message sender. We found that interruptive messages sent from supervisors are likely to reduce their overall perceived task complexity and the amount of effort for monochronic individuals in processing the main task. The reduced processing effort of the main task could potentially influence how well the main task is performed. If the main task requires detailed information processing, the reduction in processing effort would have a detrimental effect on the quality of the main task. Therefore, supervisors need to exercise caution when sending IM messages.

Conclusions

As contemporary organizations increasingly seek to improve their performance in terms of communication efficiency and effectiveness, it becomes a significant undertaking for organizations to embrace technological innovations to support information sharing and coordination with their constituents. Hence, it is important to understand the potential impacts of workplace applications of IM technology, both positive and negative. Drawing upon theoretical perspectives on interruption and polychronic communication, this study provides empirical evidence for the impact of the interruptive IM technology on employee satisfaction and subjective task complexity. Our results suggest that polychronicity is an important moderator that adjusts the effect of interruptions, with monochronic individuals being more responsive to interruptions than polychronic individuals. Interruptions decrease monochronic individuals' satisfaction with the multitasking work process and change the way they process information when they are under the pressure to process interruptive tasks from their supervisors. The results of our study also highlight the importance of considering the position power of message senders when examining the impact of innovative communication technologies. Furthermore, this research opens up additional opportunities for managers to facilitate effective use of IM technologies in the workplace and perhaps to select the right individuals for each position based on their relative polychronicity. This study provides a general research framework for this domain and sets the stage for future investigation into the interplay between individual user's psychological traits and advanced technology use and stimulates further research in this arena.

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Appendix A

Main tasks

Exact Start Time (Use the clock on computer):

Your firm is located at Albany, New York (Zip: 12250) and ships two types of boxes (Type A and Type B) to each of the warehouses on a daily basis. The approximate value of one Type A box or one Type B box is about $100.

Box A: Length: 13 inches, Width: 17 inches, Height: 9 inches, Weight: 45 pounds

Box B: Length: 6 inches, Width: 12 inches, Height: 10 inches, Weight: 16 pounds

Compare the Ground Shipping and Priority Mail rates of two companies and fill out Table A1.

UPS http://wwwapps.ups.com/calTimeCost?loc = en_US

Select these options: Shipment Type: Package/Letter, Destination Type: Commercial Address, Quote Type: Detailed Time and Cost, Select: 'I will drop off my prepaid package(s)', Daily pickup: No, Packaging: My Packaging.

U.S. Postal Service http://postcalc.usps.gov/

Select these options: Rectangular box, Priority Mail and add an Insurance of $100 under extra services.

Exact Finish Time (Use the clock on Computer):

Enter your Yahoo ID name

Table A1

Shipping rate	*UPS (Ground shipping)*		*U.S. Postal service (Priority mail)*	
Destination	*1 A Cost*	*1 B Cost*	*1 A Cost*	*1 B Cost*
Rye, New York (Zip 10580)				

Appendix B

See Table B1.

Table B1 Supplier information used for interruptive IM tasks

Orders and suppliers						
Vendor name	*Vendor no.*	*Item no.*	*Item description*	*Item cost*	*A/P terms*	*Avg. delay time (in days)*
Hulkey Fasteners	1	1122	Airframe fasteners	$4.25	30	−0.27*
		3166	Electrical Connector	$1.25		
		9966	Hatch Decal	$0.75		
		5066	Shielded Cable/ft.	$0.95		
Spacetime Technologies	2	4111	Bolt-nut package	$3.55	25	4.00
		9752	Gasket	$4.05		
		6489	O-Ring	$3.00		
		5125	Shielded Cable/ft.	$1.15		
Durrable Products	3	1369	Airframe fasteners	$4.20	45	0.00
		4569	Bolt-nut package	$3.50		
		5454	Control Panel	$220.00		
		9399	Gasket	$3.65		
		7258	Pressure Gauge	$90.00		
		5275	Shielded Cable/ft.	$1.00		
Fast-Tie Aerospace	4	5166	Electrical Connector	$1.25	30	1.00
		6321	O-Ring	$2.45		
		7268	Pressure Gauge	$95.00		
		5462	Shielded Cable/ft.	$1.05		
		5689	Side panel	$175.00		
Alum Sheeting	5	1243	Airframe fasteners	$4.25	30	1.75
		4224	Bolt-nut package	$3.95		
		5417	Control Panel	$255.00		
		5634	Side Panel	$185.00		
Steelpin Inc.	6	4312	Bolt-nut package	$3.75	30	2.53
		5234	Electrical Connector	$1.65		
		8008	Machined Valve	$645.00		
		5677	Side Panel	$195.00		
		5319	Shielded Cable/ft.	$1.10		
Manley Valve	7	9955	Door Decal	$0.55	30	0.36
		9967	Hatch Decal	$0.85		
		8148	Machined Valve	$655.50		
		6431	O-Ring	$2.85		
		9977	Panel Decal	$1.00		
		7258	Pressure Gauge	$100.50		
Pylon Accessories	8	9764	Gasket	$3.75	15	2.60
		6433	O-Ring	$2.95		

*Negative delay time means the order arrived earlier than promised by the vendor.

Appendix C

Interruptive IM tasks

Low level of interruption:

1. Which supplier has the longest A/P term?

High level of interruption:

1. Which supplier has the longest A/P term?
2. Which supplier is the best in terms of on-time delivery?
3. Which supplier has the lowest price for Airframe fasteners?
4. Which supplier has the lowest price for Shielded Cable?

Appendix D

Table D1 Survey instrument

Perceived task complexity (Maynard & Hakel, 1997)	
COMP1	I found this to be a complex task.
COMP2	This task was mentally demanding.
COMP3	This task required a lot of thought and problem solving.
COMP4	I found this to be a challenging task.
Process satisfaction (Green & Taber, 1980)	
SATP1	I would describe the entire problem solving process I just used as efficient.
SATP2	I would describe the entire problem solving process I just used as coordinated.
SATP3	I would describe the entire problem solving process I just used as fair.
SATP4	I would describe the entire problem solving process I just used as understandable.
SATP5	I would describe the entire problem solving process I just used as satisfying.
Polychronicity (Conte & Jacobs, 2003)	
POLY1	I like to juggle several activities at the same time.
POLY2	I prefer to do one thing at a time.
POLY3	I believe people should try many things at once.
POLY4	I should try to do many things at once.
POLY5	When I work by myself, I usually work on one task at a time.
POLY6	I believe people do their best work when they have many tasks to do.
Task motivation (Maynard & Hakel, 1997)	
MOTI1	I was motivated to perform well on this task.
MOTI2	This task was interesting to me.
MOTI3	I put a lot of effort into coming up with the best possible solution.
Perceived workload (Moore, 2000)	
LOAD1	I feel busy or rushed.
LOAD2	I feel pressured.
LOAD3	I feel that the number of requests or problems I deal with is more than expected.
LOAD4	I feel that the amount of work I do interferes with how well it is done.